Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

SEPTEMBER, 1948

TABLE OF CONTENTS, Page 35

CHNOLOGY DEPARTMENT

83%
OF THE MANUFACTURERS EXHIBITING AT THE IRON AND STEEL EXPOSITION WHO USE BEARINGS IN THEIR PRODUCTS
use TIMKEN® bearings
TIMKEN
MADE IN U.S.A.

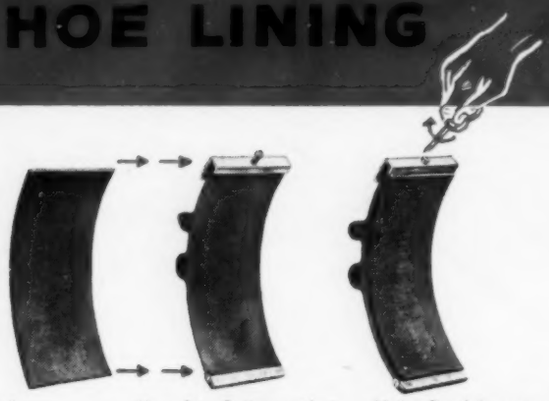
Of a total of 136 exhibitors at the 1948 Iron And Steel Exposition in Cleveland, 65 actually manufacture equipment requiring bearings; 54 of these manufacturers, or 83%, use Timken tapered roller bearings.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

THE TIMKEN ROLLER BEARING COMPANY
CANTON 6, OHIO - CABLE ADDRESS "TIMROSCO"

NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

Now... An Important New
RIVETLESS CLAMP-ON TYPE
MILL BRAKE SHOE LINING



New lining, No rivets, 100% braking area.

New shoe, Buttress at bottom, simple self-aligning screw jack at top.

Lining fixed, in permanent non-shifting position by action of screw jack.

Renewed in a Jiffy... on the Job!

One of the most important and recent advances in steel mill brake practice is a new **rivetless,** clamp-on type of brake shoe and lining . . . another product of Cutler-Hammer pioneering. In this new type of construction, the lining is not riveted to the shoe but securely clamped in place. The lining is held at the bottom by a buttress on the shoe. Tightening a self-aligning screw jack at the top, bows the lining until it conforms to the arc of the shoe, and securely wedges it in place.

To renew a worn lining, you simply loosen the screw, push the old lining **out,** the new lining **in,** and re-tighten the screw. The task now is quick and easy.

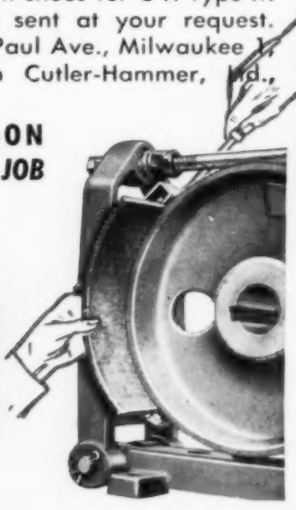
You no longer have to carry on hand a stock of spare brake shoes with riveted linings. Just the inexpensive linings themselves are all the "spares" you need.

And since the lining is not weakened nor its effective braking area reduced by rivet holes, the lining lasts much longer. Users are amazed at the difference.

Complete details of C-H Type M magnetic brakes with clamp-on linings, and replacement shoes for C-H Type M brakes now in service, will be sent at your request. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

HOW RIVETLESS CLAMP-ON LINING IS *RENEWED ON THE JOB*

1. Loosen jack screw.
2. Pull out old lining, slip in new.



PROVEN PERFORMANCE

Exhaustive "in-the-field" tests prove this new C-H design will meet the most exacting and severe service.

CUTLER-HAMMER
MOTOR CONTROL
C-H

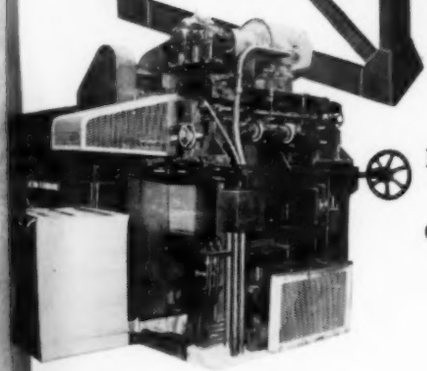
IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States, $8.25 Canada, $10.00 foreign countries. Volume 25, No. 9

SPEED TIN PLATE PRODUCTION

Automatic Feeding and Electrolytic Pickling Line Offers Advantages Over Conventional Methods

HERE'S a great forward step in Hot Dip Tinning. A feeder automatically places sheets into an electro-pickling unit for automatic processing before tinning. These 21 revolutionary lines, now in operation at Irvin Works, Carnegie-Illinois, offer 5 distinct advantages over conventional methods:

1. **Eliminates much of the disagreeable and costly preparation of black plate before tinning.**
2. **Surface is better prepared for tinning.**
3. **Reduces number of menders and "waste-waste."**
4. **Increases tinning speeds (in this particular installation, production increased to 500" per minute).**
5. **Lowers production costs.**



A "Shenango" type tin plate feeder th magnetic riffling attachments.

verhead conveyor and right angle d for either two or three way feeding.

Co-operation between Carnegie-Illinois and Aetna-Standard engineers made this line possible. The principle was originally developed by Tennessee, Coal, Iron & Railroad Co. The equipment built by Aetna includes: Roller Gravity Conveyor; Modified "Shenango" Feeder; Magnetic Overhead Conveyor; Roller Table; Sheet Matching & Double Throw-out Device; Electrolytic Pickler and Water Spray and Rinse Tank.

THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES:

HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
AETNA-STANDARD ENGINEERING COMPANY, LTD., TORONTO, ONTARIO, CANADA

"All The Way from Design to Erection" is far more than a slogan with Heyl & Patterson. It is a plan of operation wherein each essential function from design to successful operation is performed by the one organization.

The many years of successful application of this plan of operation has developed a spirit of teamwork on the part of the Heyl & Patterson design, electrical, fabrication, machine shop and erection departments.

This teamwork permits the successful execution of our contracts for Heavy Bulk Materials Handling Equipment on time and on a basis that brings years of satisfaction to our customers.

What makes them TICK ?

H&P field specialists have become acquainted through the years with the manner in which every other part of the team operates. Because of this knowledge they can do a better erection job for you.

Ore Bridges
Railroad Car Dumpers
High Lift-Turnover-Rotary
Coal & Coke Handling Equipment
Boat Loaders & Unloaders
Pig Iron Casting Machines
Rotary Mine Car Dumpers
Coal Crushers
Coal Storage Bridges
Car Hauls & Boat Movers
Bradford Breakers
Refuse Disposal Cars
Thorsten Coal Samplers

Heyl & Patterson, Inc.

"SINCE 1887"

55 WATER STREET · PITTSBURGH 22, PA.

WE ARE BUILDERS

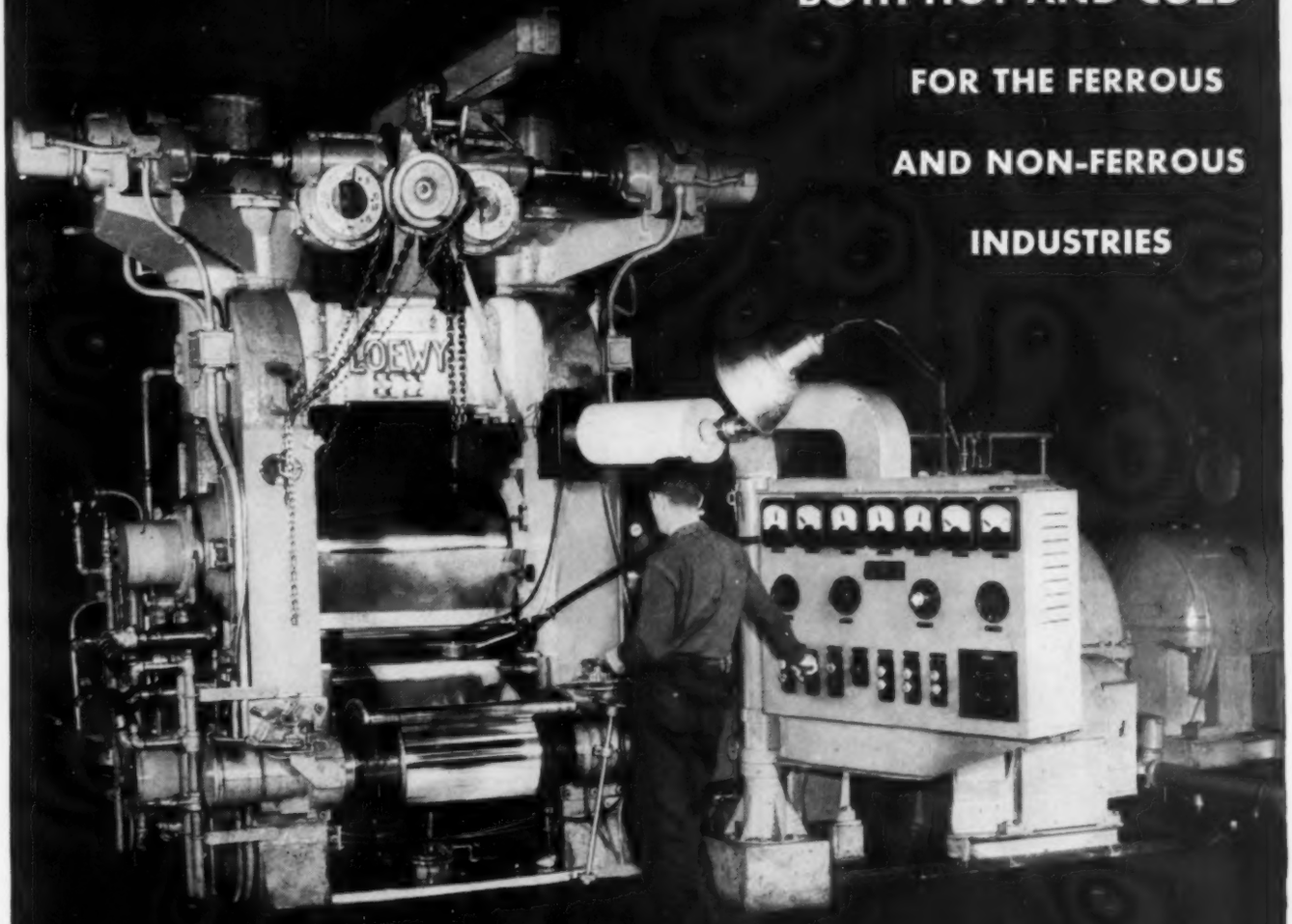
OF SPECIALIZED ROLLING MILL EQUIPMENT

BOTH HOT AND COLD

FOR THE FERROUS

AND NON-FERROUS

INDUSTRIES



BY COURTESY OF THE ALUMINUM COMPANY OF CANADA, LTD.
INSTALLATION AT KINGSTON PLANT

FOUR-HIGH
HIGH SPEED ROLLING MILL
FOR STRIP AND FOIL

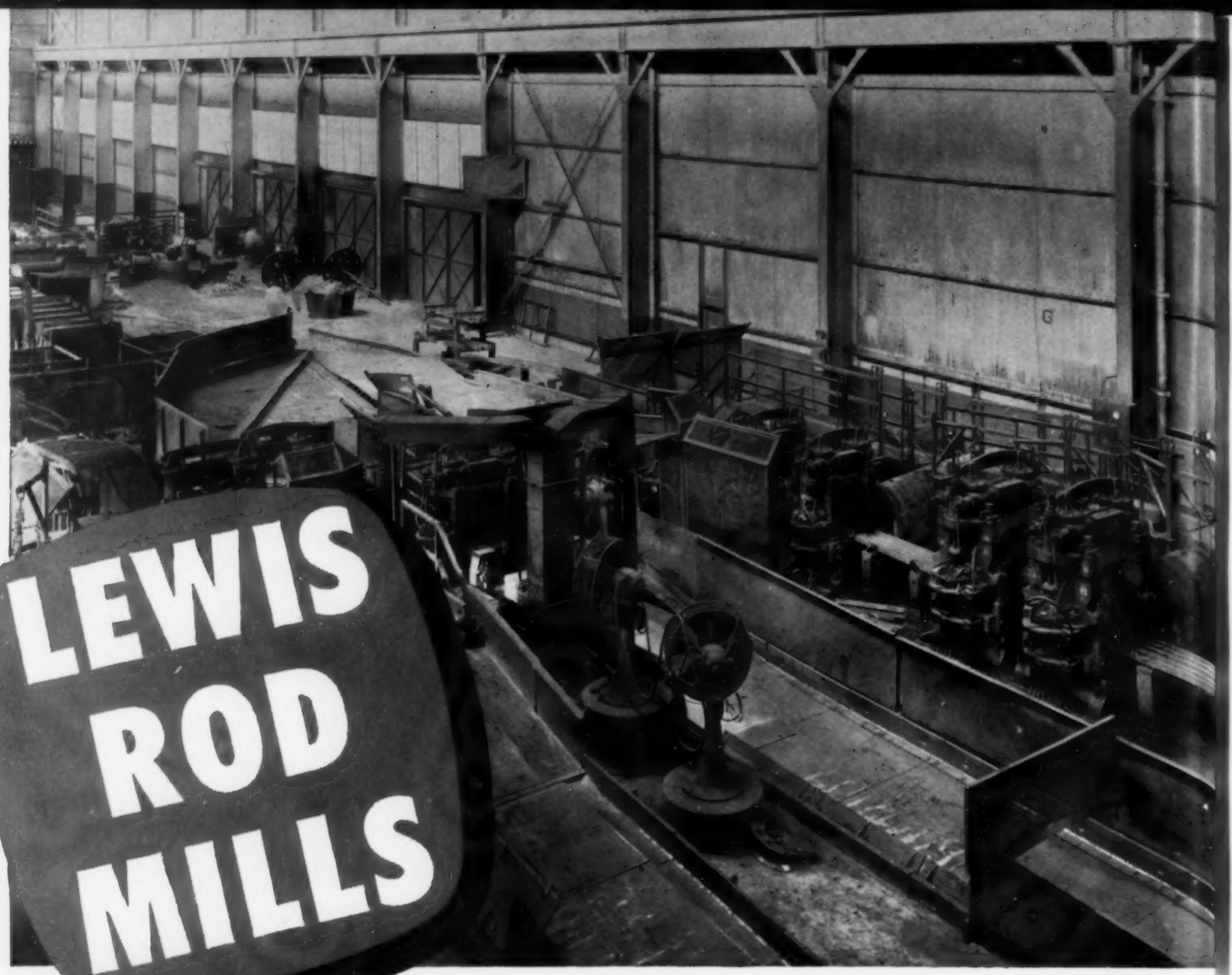
HYDROPRESS · INC.

ENGINEERS *CONTRACTORS*

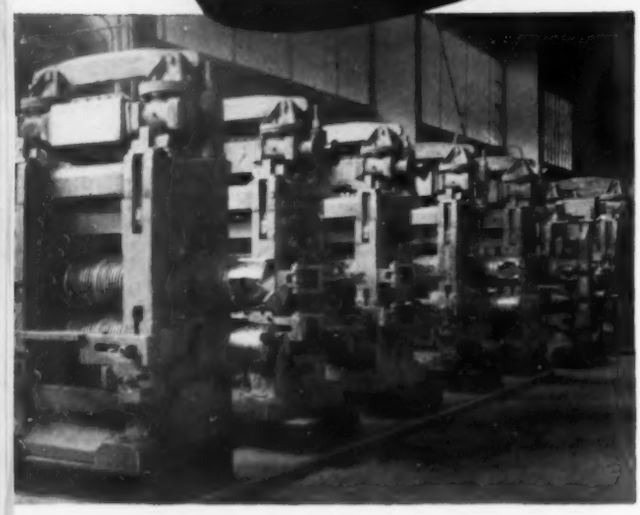
HYDRAULIC PRESSES · ROLLING MILLS · PUMPS
ACCUMULATORS · DIE CASTING MACHINES

566-568 LEXINGTON AVENUE · NEW YORK 22 · N. Y.

CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C.



LEWIS ROD MILLS



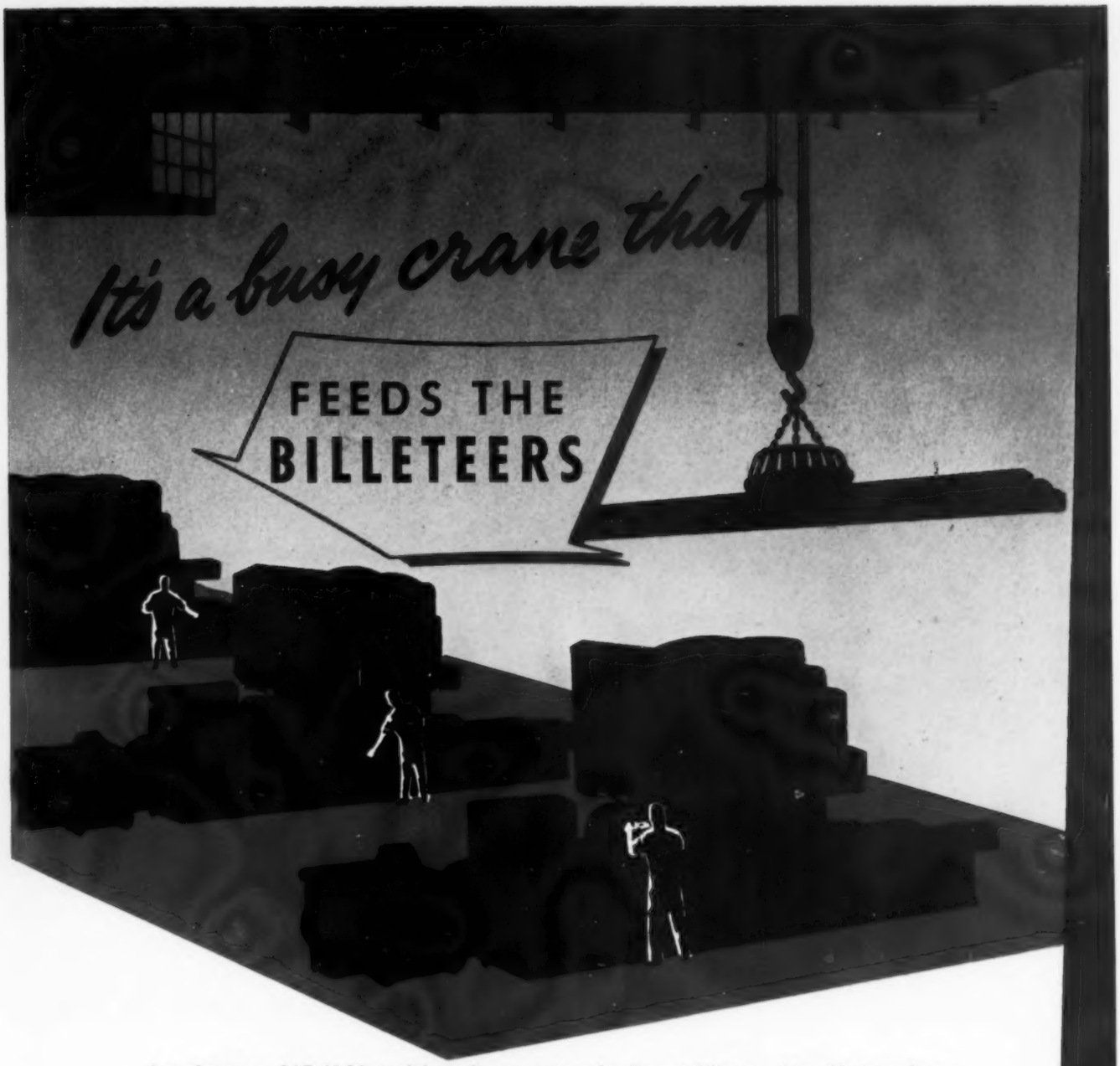
★ HIGH TONNAGE MILLS OF GREAT FLEXIBILITY

In both continuous and semi-continuous types, Lewis Rod Mills are designed to handle a diversified output of highly specialized alloy steels . . . Lewis engineers welcome the opportunity to develop new rolling machinery for your particular requirements.

MANUFACTURERS OF
ROLLS AND ROLLING MILL MACHINERY
FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES

LEWIS FOUNDRY & MACHINE

DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.



Actual tests on SAE 4150 steel show the operator of a Bonnot Billeteer chips 49 times faster than a man with a chipping hammer.

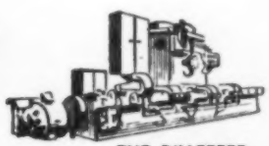
The smooth, steady operation of the Billeteer maintains a flow of clean billets ready for rolling. You can depend on the Billeteer, and large inventories are not necessary. Flaws one inch or more in depth are quickly cut out, salvaging steel that would have to be remelted in plants not equipped with this modern machine.

Bonnot Billeteers replace one of the most gruelling manual chores left in steel production, and do so at overall costs up to 50-60% under hand chipping costs.

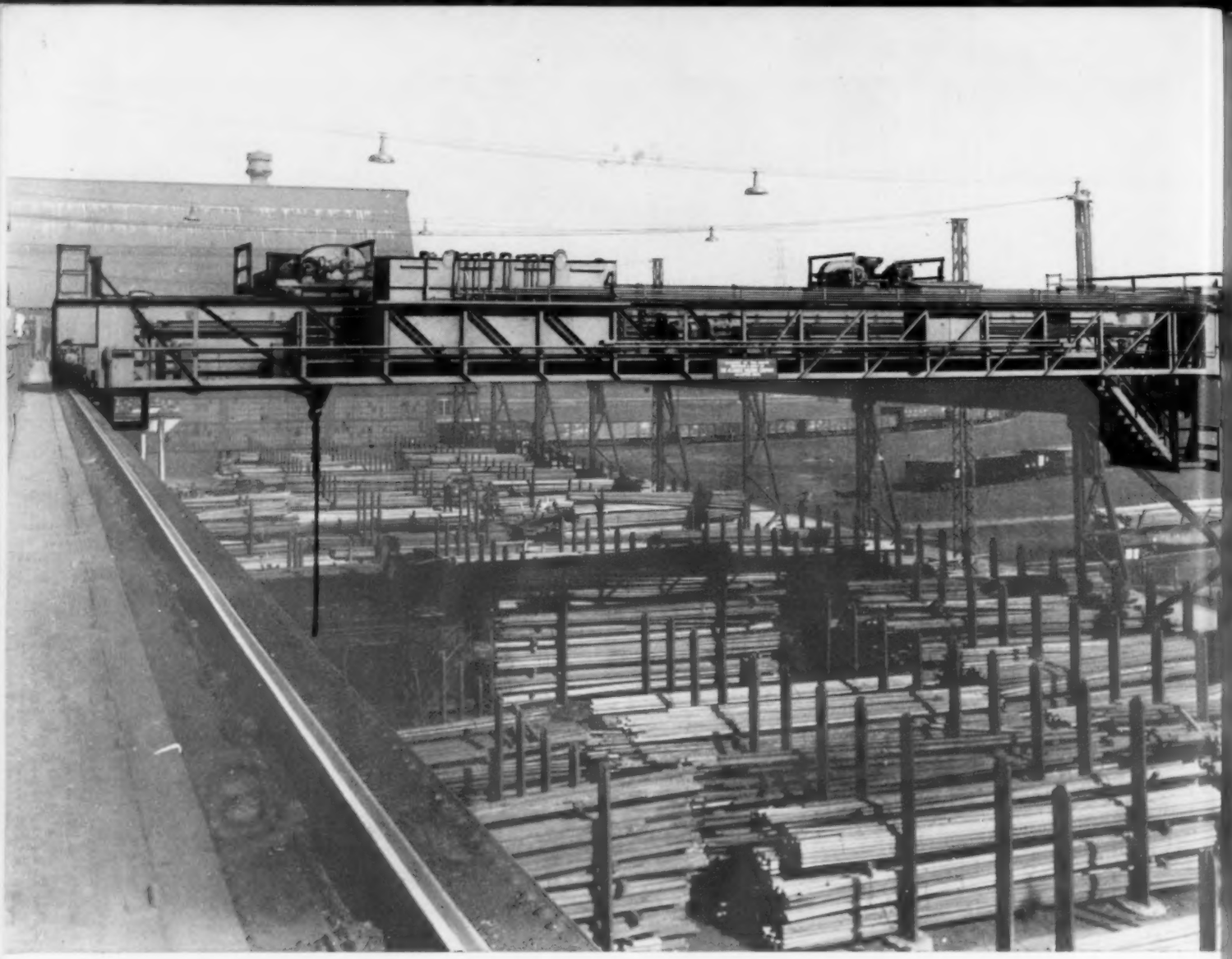
Why not lick the manpower problem in your billet sheds by putting Bonnot Billeteers on your payroll? Complete information is furnished on request.

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER



Alliance KEEPS HEAVY INDUSTRY ON THE MOVE

Wherever production schedules must be maintained hour after hour—24 hours a day—week after week—you'll find rugged, dependable Alliance equipment on the job. Alliance cranes—like the 15-ton double trolley, 102-foot span yard crane shown above—keep heavy industry on the move day in, day out, because they're built for long, continuous service . . . to help plants maintain smooth-flowing production schedules at less operating cost.

Alliance engineering specialists have designed and developed thousands of cranes to handle all types of loads . . . quickly, safely, and easily . . . in many different industries. Let Alliance—World's Largest Builder of the World's Largest Cranes—develop the equipment best suited to your company's material handling operations.

MAIN OFFICE PITTSBURGH OFFICE

THE ALLIANCE MACHINE COMPANY · ALLIANCE, OHIO · 1622 OLIVER BLDG., PITTSBURGH, P

Consult Alliance on

LADLE CRANES · GANTRY CRANES · FORGING MANIPULATORS
SOAKING PIT CRANES · STRIPPER CRANES · SLAB AND BILLET
CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES
SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION

Alliance

Here's the new *EASY* index method of selecting *MORGANITE* MOTOR BRUSHES!

EXACT, CONCISE INFORMATION FOR SPECIFYING BRUSHES FOR TYPES MC, MD, CD, SWS, SK AND T MOTORS

MORGANITE engineers expressly prepared this comprehensive booklet to save the time of purchasing agents, steel mill engineers and production maintenance men when selecting motor brushes. Complete information is contained therein covering all types of motors commonly used, and the brushes best suited for efficient, uninterrupted operation.

While the text is not a detailed technical treatise, it is an invaluable reference. It has been edited with the purpose of reducing steel mill motor maintenance costs through proper brush specification.

Your copy will be sent promptly on request; please write on company letterhead.

Morganite INCORPORATED REGISTERED TRADE MARK CARBON BRUSHES

LONG ISLAND CITY 1 • NEW YORK

WELDING eliminates the trouble-some joints — stabilizes the resistance value — reduces maintenance

TRADE MARK

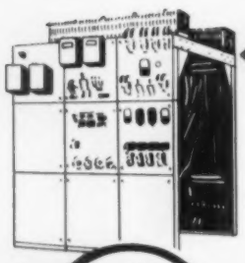
TAB WELD PLATE RESISTORS

For CONTROLLER and STARTER DUTY

These are steel plate resistors having end-convolutions offset to bring grid-ends into intimate contact with each other. Welding the mated grid tab-ends together gives an *efficient path* for current flow—*heating is uniform* throughout the entire section.

Tap-plates, welded to the resistors at frequent intervals, afford *rigid terminals* for connecting external wires. To change taps, only the external wire or flat-bus need be shifted—*the terminal-plate remains stationary*, ready for re-connection, if needed.

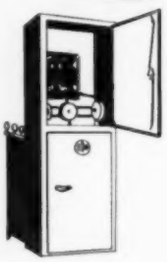
For reduced resistor maintenence, specify EC&M TAB-WELD Plate Resistors. See them at the show. Ask for Bulletin 942.



REDUCED MAINTENANCE where MAINTENANCE can easily be neglected—

Resistors are usually mounted in out-of-the way places (high overhead, enclosed or similarly obscured). EC&M's TAB-WELD design keeps resistance tight, independent of the clamping-nuts. Eliminate failures with TAB-WELD Resistors.

ALSO ON DISPLAY AT THE IRON & STEEL SHOW
SPACE No. 135, 136, 137



VALIMITOR Motor Starters

•

MILL and CRANE Controllers

•

Type WB Magnetic BRAKES

•

CAM Master Switches

•

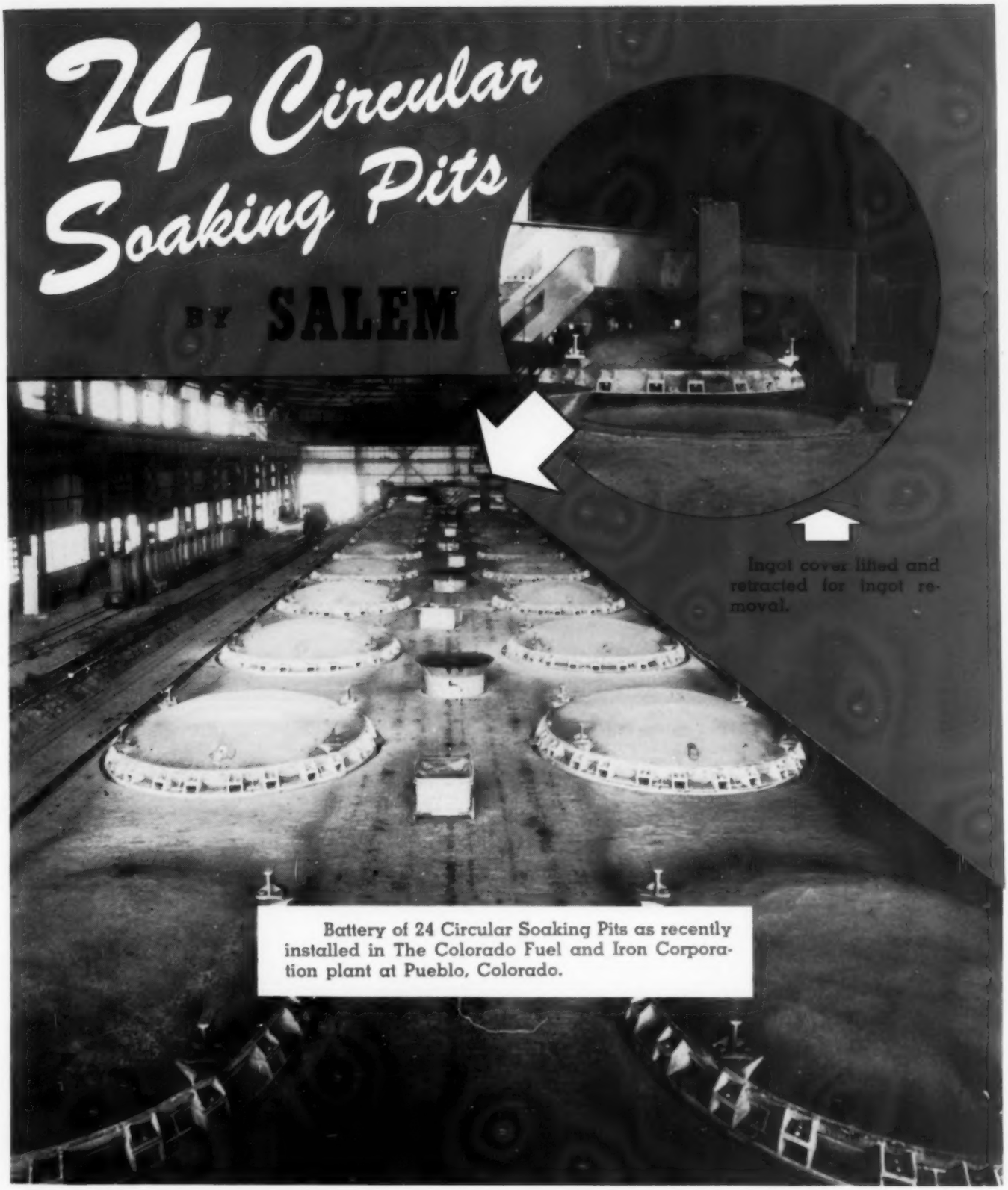
YOUNGSTOWN Safety Limit Stops

E&M

THE ELECTRIC CONTROLLER & MFG. CO.

1698 EAST 79TH STREET ★ CLEVELAND 4, OHIO

24 Circular Soaking Pits BY SALEM



Ingot cover lifted and retracted for ingot removal.

Battery of 24 Circular Soaking Pits as recently installed in The Colorado Fuel and Iron Corporation plant at Pueblo, Colorado.

Every Salem office has the facts! Address nearest city listed below

P-7

Salem Engineering Company

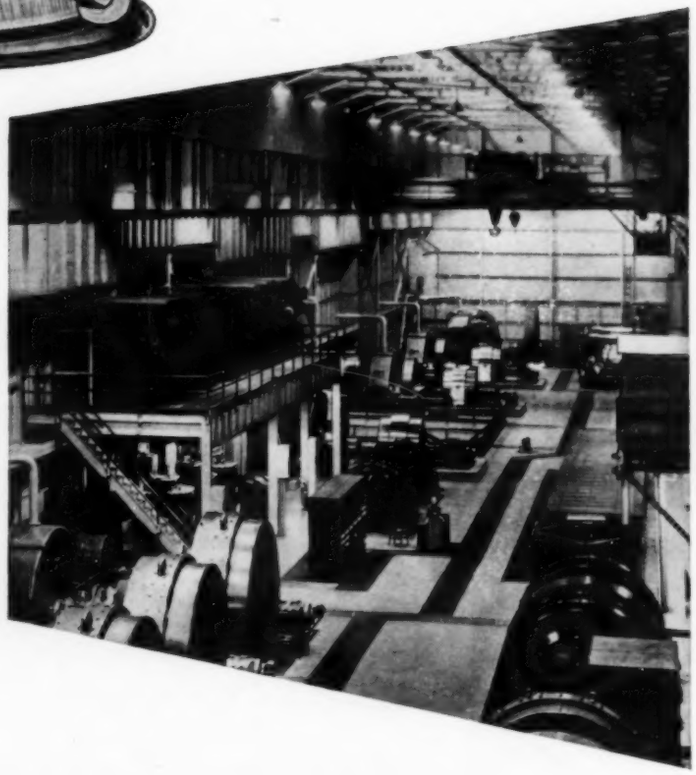
HEADQUARTERS FOR HEAT TREATING DESIGN

Salem, Ohio *Southwest Office, Fort Worth, Texas*

Salem Engineering (Canada) Ltd., Toronto, Ont. · Salem Engineering Company, Ltd., Sheffield, England

PRODUCT OF HOLOPHANE RESEARCH . . .

HIBAY*



CHECK THESE HIBAY ADVANTAGES

1. Sturdy Prismatic HIBAY Reflectors for 500 to 1500 watts incandescent; 400 and 1000 watts mercury.
2. An aluminum cover is permanently spun over external prisms using a mastic seal at the joints.
3. Five different prismatic reflectors offer exact lighting pattern required.
4. Lamp focus adjustment allows intermediate settings.
5. Prismatic glass surfaces are impervious to chemical action from fumes or soot.
6. Smooth glass surfaces are easy to keep clean.
7. Tripod holder and ring grip reflector to assure exact positioning of lamp.
8. Outside socket construction favors trouble-free lamp burning.
9. Steel parts plated to resist corrosion.

Send for data sheet giving full optical and mechanical information for the entire line of HIBAY equipment.

*Reg. U. S. Pat. Off.

HOLOPHANE COMPANY, INC.

Lighting Authorities Since 1898 · 342 MADISON AVENUE, NEW YORK 17, N. Y.

THE HOLOPHANE COMPANY, LTD., THE QUEENSWAY, TORONTO 14, ONTARIO

BROSIUS Steel Mill and Blast Furnace Equipment will modernize Your Plant and Increase Production

Brosius 6,000 pound Auto Floor Box Charger. Charges any kind of scrap for Melting Furnaces.

Brosius 16,000 pound Auto Floor Charger. Handles Ingots and serves Reheating Furnaces, also Presses.

Brosius Automatic Single Hoist Grab Bucket.

Brosius Equipment and its reputation is based on forty years of experience in meeting all kinds of production problems. This applies, not to one or two specialty items, but to the entire line of Brosius Equipment from Auto Floor Charging Machines to Soaking Pit Cover Carriages.

Today's intensified demands for production points to the necessity of improvement and utilization of better equipment designed for your present and future needs.

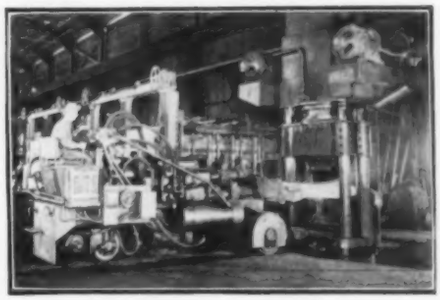
The Brosius organization takes time to analyze and study your particular needs before recommending specific equipment.

Brosius designed and manufactured products shown here are several of an extensive line. Some, such as the Auto Floor Charger and Manipulator, are so designed and equipped that they are dual purpose machines, with either electric, or diesel electric drive.

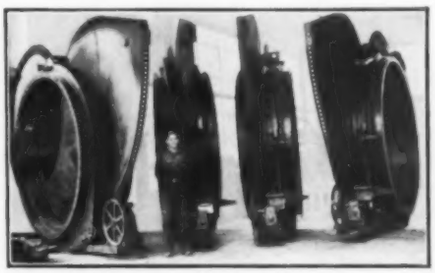
Our Blast Furnace Clay Guns can be produced to meet individual requirements. Speed of swing of the boom or pedestal and nozzle pressures up to 600 pounds per square inch, or more, can be suited to your operation.

Perhaps you are considering means of stepping up your production. If so, a Brosius representative will gladly call at your convenience to discuss and study the application of any Brosius Products to your requirements. There is no obligation.

Before you buy, let us remind you that "BROSIUS" is a synonym for Economy, Quality and Careful Engineering service.



Brosius Auto Floor Manipulator built in capacities of from 2,000 to 20,000 pounds.



Brosius Goggle Valves built for either Motor or Hand Operation.

Brosius Clay Guns are available for either Pedestal or Column Mounting. Pressures available to suit your needs and speed of Gun swing, according to your Specifications.

Other Brosius Products Include Cinder Notch Stoppers for Stopping Cinder Notch of Blast Furnaces; Flue Dust Conditioners for Blast Furnaces; Coke Testing Tumbling Barrels; Dry Slag Granulating Mills, and Soaking Pit Cover Carriages.

WRITE FOR OUR NEW DESCRIPTIVE CATALOG CONTAINING ADDITIONAL ITEMS

Brosius Equipment is covered by patents, allowed and pending, in the United States and Foreign Countries.

Edgar E. BROSIUS Company Inc.

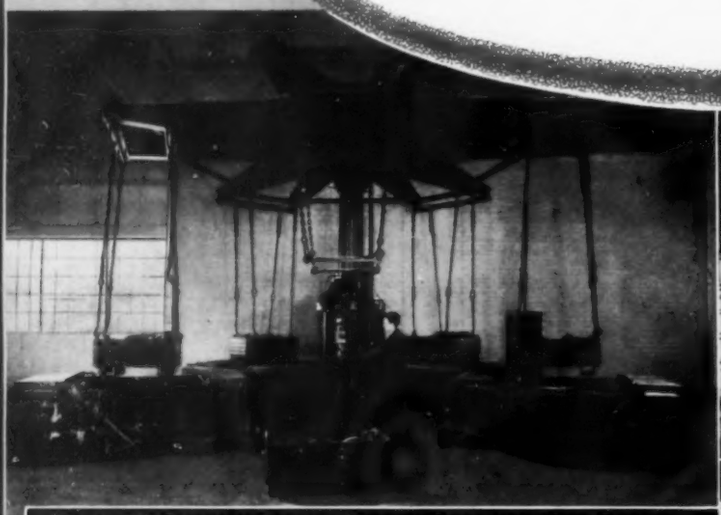
Designers & Manufacturers of Special Equipment for Blast Furnaces & Steel Mills

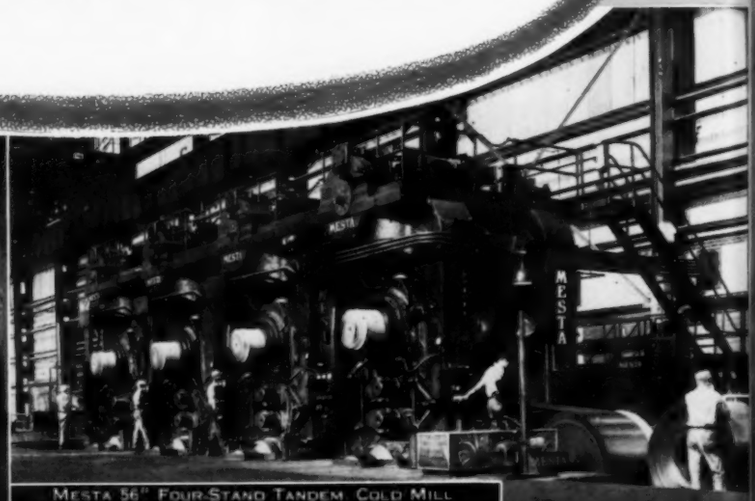
SHARPSBURG, Pittsburgh (15) PENNSYLVANIA

Brosius Equipment is constantly being improved to meet new and more difficult requirements of present-day production.

DESIGNERS and BUILDERS of COMPLETE STEEL PLANTS

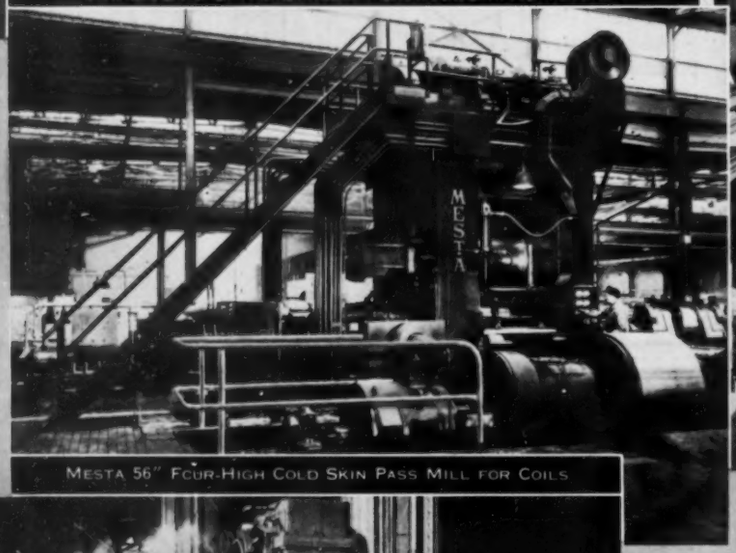
MESTA





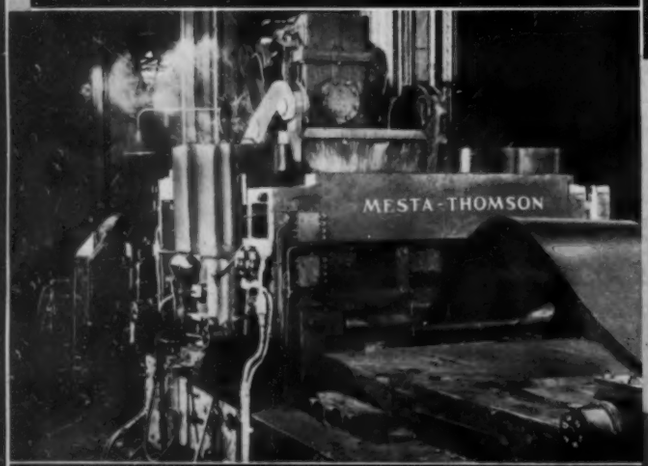
MESTA 56" FOUR-STAND TANDEM COLD MILL FOR THIN SHEET STRIP AND GALVANIZING STOCK

MESTA 32" PATENTED PICKLING MACHINE PROCESSING DROP FORGINGS IN THE PLANT OF A PROMINENT AUTOMOBILE MANUFACTURER

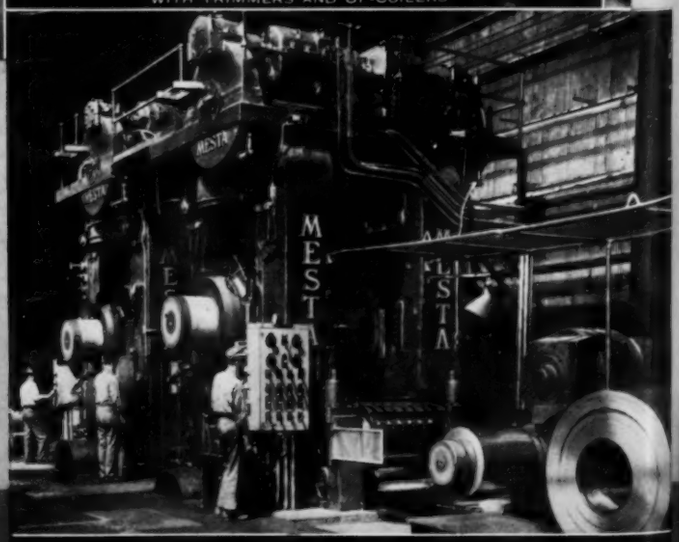


MESTA 66" CONTINUOUS PICKLING LINES WITH TRIMMERS AND UP-COILERS

MESTA 56" FOUR-HIGH COLD SKIN PASS MILL FOR COILS



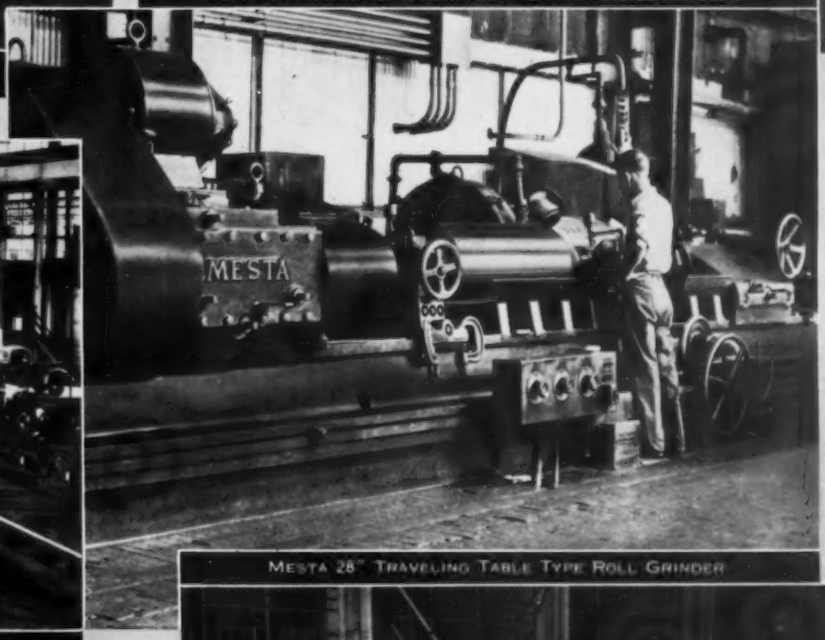
66" MESTA-THOMSON FLASH WELDER INSTALLED AT THE ENTRY END OF A HIGH-SPEED CONTINUOUS PICKLING LINE



MESTA 42" TWIN HIGH-SPEED FOUR-HIGH COLD SKIN PASS MILL

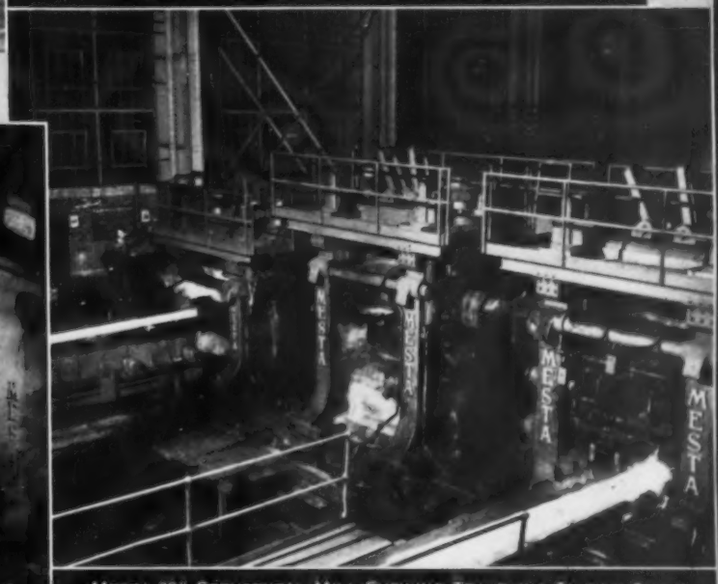
MESTA 59" x 130" HEAT TREATED
SPECIAL ALLOY STEEL BACKING-UP ROLL

MESTA 28" FOUR-STAND TANDEM MILL FOR THE
COLD REDUCTION OF STAINLESS AND HIGH SILICON STEELS



MESTA 28" TRAVELING TABLE TYPE ROLL GRINDER

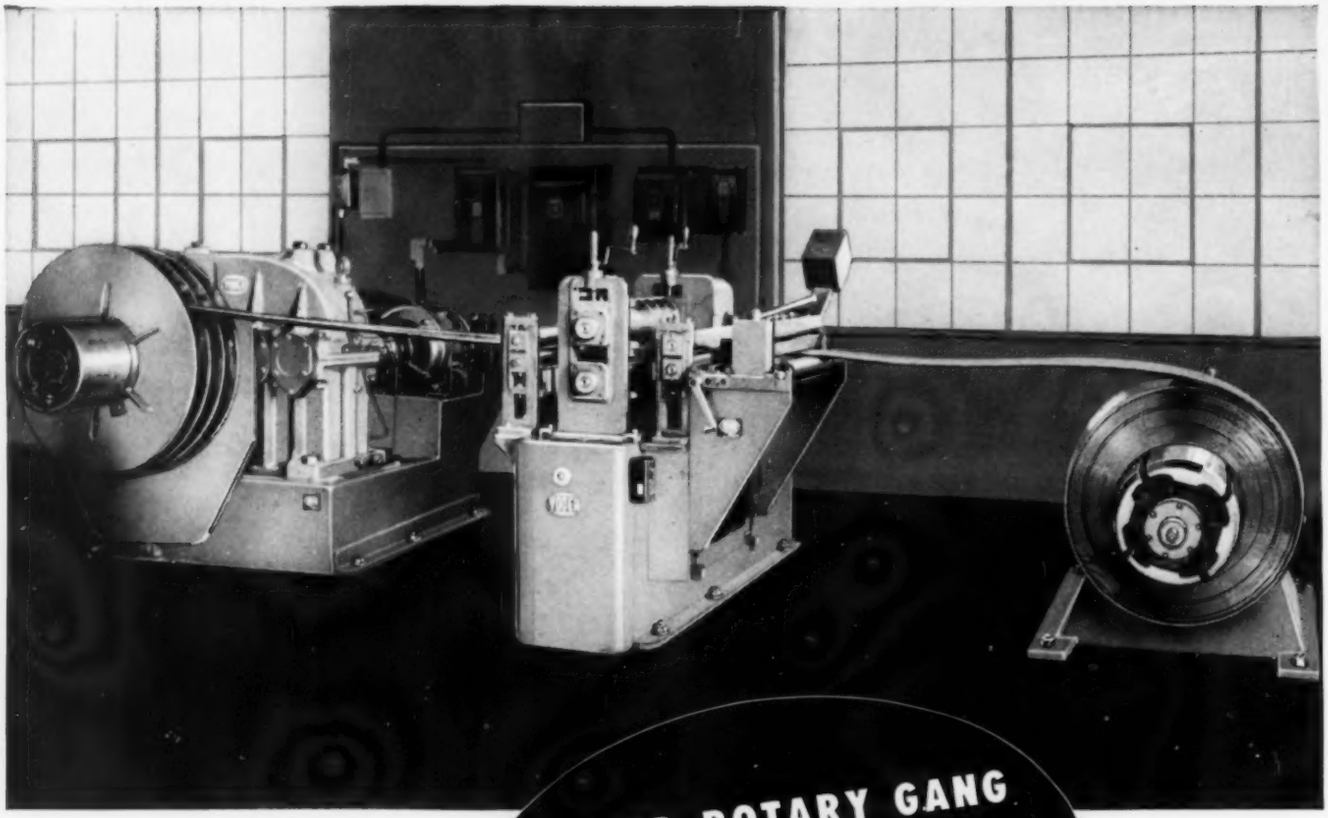
MESTA 18" - 14" - 10" MERCHANT MILL



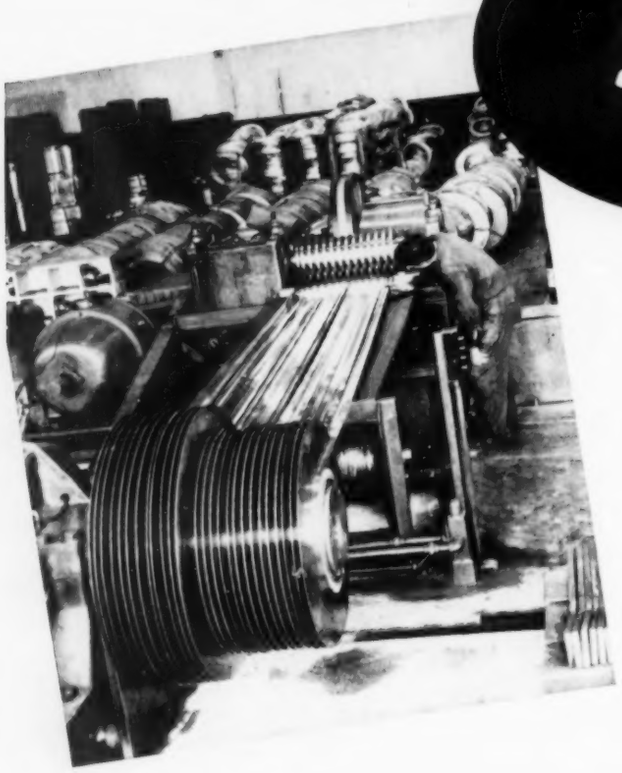
MESTA 29" STRUCTURAL MILL SHOWING TRAVELING TILTING TABLE

THE FIRST FOUR-HIGH TANDEM MILL INSTALLED IN THIS COUNTRY
FOR THE PRODUCTION OF WIDE ALUMINUM STRIP SHEETS

MESTA MACHINE COMPANY · PITTSBURGH, PA.



YODER ROTARY GANG *Slitting Lines*



Because of their sturdy construction, great accuracy, and many features insuring easy, trouble-free operation, Yoder rotary gang slitters outsell all other makes. They are chosen by the majority of America's leading flat rolled metal producers and fabricators who are looking for the utmost in performance and mechanical excellence.

Slitting tolerances can be held to plus or minus .004" or even less, of absolute accuracy. The output is so great that a Yoder slitter will pay for itself in the first 100 days of operation. Literature, Estimates, Consultations—for the asking.

THE YODER COMPANY
5497 Walworth Avenue Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING

ROLL FORMING, TUBE MILL AND SLITTING MACHINERY

KNOW WHAT THEY WANT

Utilities and Industrials enthusiastically accept Roller-Smith Outdoor Exotherm Breakers for the high standards of engineering craftsmanship and materials incorporated in all Roller-Smith circuit breakers.

ROLLER-SMITH OUTDOOR OIL CIRCUIT BREAKER

Outdoor Oil Circuit Breakers are available in the following classes: 50-OC-1: 600 Amperes, 7500 volts, 50,000 KVA I.C.; 50-OC-11: 600 amperes, 15,000 volts, 50,000 KVA I.C. and 100-OC-11: 600 amperes, 15,000 volts, 100,000 KVA I.C. manually operated, d-c solenoid operated or a-c rectified solenoid operated.

CHECK THESE OUTSTANDING FEATURES:

- *Exotherm Arc Extinction* — Short interrupting time — less contact burning — less oil sludging.
- *Arcing Contacts* — Heat resisting "ELKONITE" arcing surfaces.
- *Shock Absorbers* — Sturdy construction — dissipates energy of opening stroke.
- *Terminal Connectors* — Convenient, reliable, bolted type.
- *Current Transformers* — Bushing type — low excitation current.
- *Porcelain Bushings* — Wet process type.
- *Operating Mechanism* — Rugged construction — trip free at any moment of closing stroke.
- *Position Indicator* — Mechanical, visible indicator.
- *Oil Separator* — Centrifical type; removes oil from exhaust gases.
- *Breaker Frame and Tank* — Continuous seam welded — weather proof — oil tight.
- *Mounting Frame* — Rigid electrically welded construction.
- *Tank Lifter* — Portable, windlass type.

More than 40 years of research and experience is your assurance of reliable performance.

SEE US AT THE IRON & STEEL SHOW, CLEVELAND, OHIO, SEPT. 28TH. THRU OCT. 1ST.

ROLLER SMITH

Sales Representatives In all Principal Cities

ROLLER-SMITH BETHLEHEM PENNSYLVANIA

ELECTRICAL INDICATING INSTRUMENTS • AIRCRAFT INSTRUMENTS • SWITCHGEAR
AIR AND OIL CIRCUIT BREAKERS • ROTARY SWITCHES • RELAYS • PRECISION BALANCES

"ROUND IRON FOR SHIP BOLTS AND OTHER USES"

Water wheel driven tilt hammer, "tail helve" type, in an early Pennsylvania forge—Photo by courtesy of Mr. John Knox

Clipper ships needed bolts—big bolts and long bolts. To make them and other round rods, early ironmasters harnessed water power to tilt hammers, turning the billet in a grooved anvil while it was being forged into rods.

In 1810, Rentgen was granted the first United States patent for "rolling iron round, for ships' bolts and other uses." By 1870 a Bedson continuous wire rod mill, first of its kind in this country, was in operation in Massachusetts.

In the same year, Pittsburgh Rolls began serving the iron and steel industry by supplying rolls that produce at *less cost per ton of steel rolled.*

PITTSBURGH ROLLS Division of Blaw-Knox Company
PITTSBURGH 1, PENNSYLVANIA

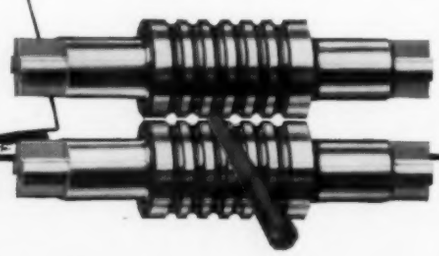
ROLLS FOR RODS AND ROUNDS

Roughing stands: Phoenix "A" Alloy Steel, Phoenix Metal, or Pittsburgh Grade 25 Grain Type.

Intermediate stands: Harder grades of Phoenix Metal or Phoenix "K" Grain Alloy Iron, except where a tougher, stronger roll is required in which case Pittsburgh Grade 25 Grain Type is suitable.

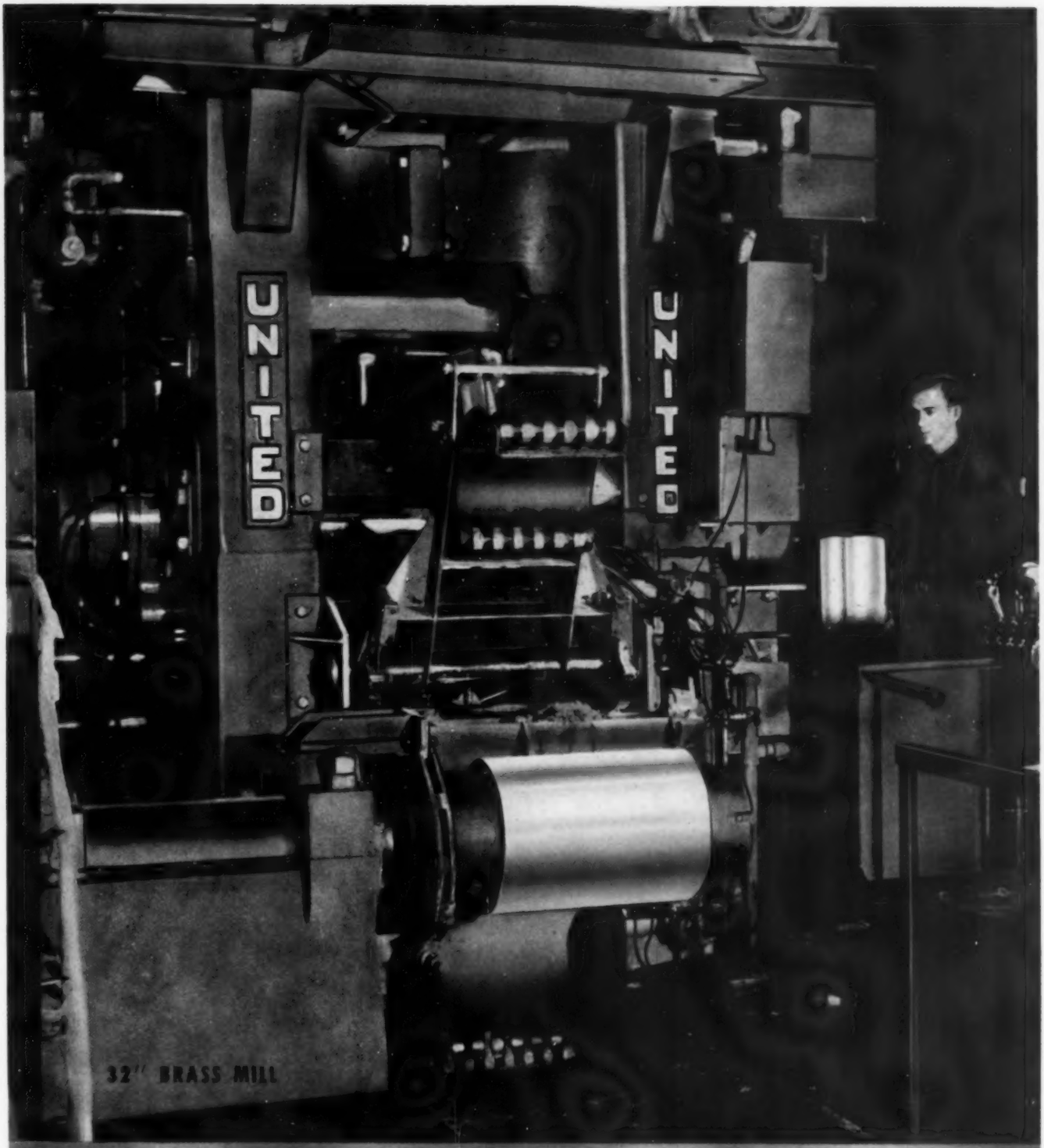
Leader and Finishing stands: Chilled Iron, an excellent material which imparts a good finish.

Final stands for larger rounds: Phoenix Metal or Phoenix "K" Grain Alloy Iron, because of deeper penetration of hardness and additional strength.



SEND for Catalog No. 2090 giving recommended rolls for all types of mills.

P.R.W **PITTSBURGH ROLLS**



Designed and Built by

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at: **PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON**

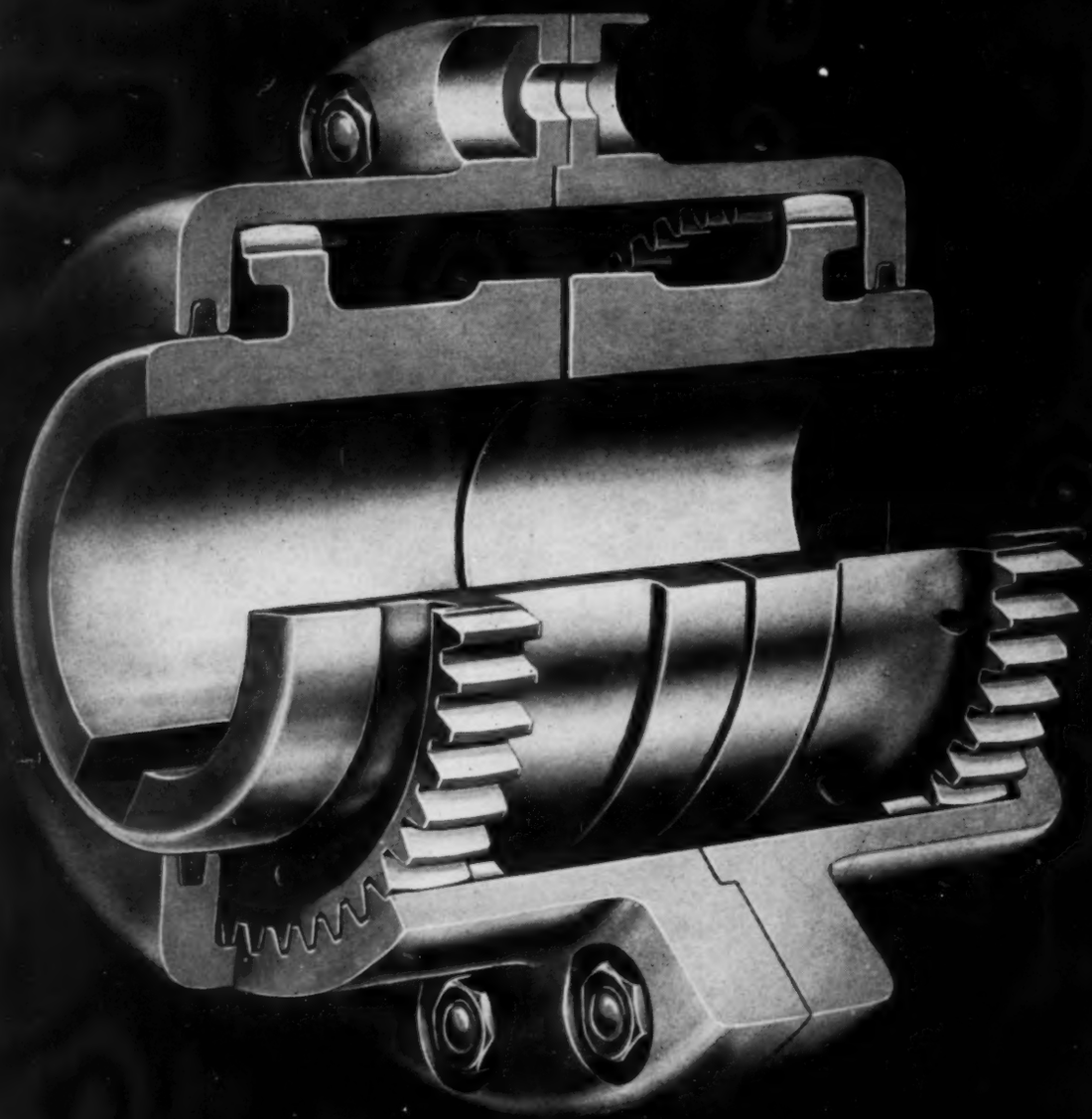
Subsidiary: **Adamson United Company, Akron, Ohio**

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada
S. E. C. I. M., Paris, France

Designers and Makers of Rolls and Rolling Mill Equipment

UE&FCO
REG. T. M.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD

PRODUCT *Information*

ON ANY OF THE PRODUCTS MENTIONED IN THIS ISSUE

Below is an index of products referred to in editorial and advertising pages of this issue. If you desire additional information on any of them, use one of the accompanying postcards in requesting it. In each case give name of product and page number. The information will come to you directly from the manufacturer involved.

PRODUCTS INDEX

Air conditioner....189
Annealing furnaces....214
Anti-friction bearings. Cover I, 139, 202, 230
Aspirator mixer....209

Bearings, anti-friction....202, 230
Billet chippers.... 5
Blowers.... 26
Boxes, charging....144
Brake, portable....178
Brake shoe lining....Cover II
Brakes, industrial....159
Bronze....191
Brushes, carbon....7, 141, 180

Cables, insulated wires and. 32, 155, 161, 227
Cars, cinder....208, 213
Chain, alloy....179
Chain, magnet suspension....192
Chippers, billet.... 5
Circuit breakers.... 15
Coke plant construction....150, 151
Cold drawing machinery....215
Combustion process....217
Conditioner, air....189
Conductor, aluminum....155
Control, electrical....211
Controls and instruments, combustion...201
Converter, bessemer....176
Couplings....19, 163, 190, 194
Crane cab conditioner....191
Cranes....6, 30, 152, 194
Cutting, powder....204

Dial scale mechanism....170
Drives, adjustable speed.... 22
Drives, rolling mill.... 28

Electrical equipment....145
Erection and design of mills and equipment.... 2

Filters....198
Fire brick....197
Floor charging machines.... 11
Furnaces....21, 25, 222
Furnaces, annealing....214
Furnaces, electric.... 38
Fuses....183

Gas-electric generator....176
Gear drives....169
Gears....195
Generator, gas-electric....176
Graphite....178
Graphite, carbon....196
Guides, mill....207

Heaters, unit....160, 193
Hoist control....211
Industrial lighting.... 10
Industrial trucks....203
Inhibitors....172
Insulated wires and cables. 32, 155, 161, 227
Insulators....199

Jets, steam.... 19

IRON AND STEEL ENGINEER September, 1948

Please send me additional products information as requested below:

Product and Page No.....

" " " " .....

" " " " .....

Name.....

Title or Position.....

Company.....

Address..... City..... Zone.... State.....

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 510, P. L. & R. Pittsburgh, Pa.

IRON AND STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.

PRODUCTS INDEX — (Continued)

Lighting, industrial 10
Lubricants 184, 186
Lubricating systems and equipment ..... Cover III, 165

Machine, straightening 156
Magnets, lifting 177
Mills, pug 170
Mills, rod 4
Mixers, aspirator 209
Monel metal 200

Ore unloaders 148

Pickling line, electrolytic 1
Pillow blocks 210
Pipe cleaning 191
Powder cutting 204
Pressure recorders 173
Pug mill 170
Pumps 168

Railroad siding construction 191
Recorder, smoke 175
Rectifier stacks, oil-immersed 160
Reels, cable 175
Refractories 153
Refractory concrete 219
Resistors, plate 8
Resistors, steel grid 212
Rolling mill machinery 3, 24
Rolling mills 19, 146, 174
Rolls 16, 167, 187

Saws, high speed friction 188
Saws, masonry 185
Shear blades and rotary knives 162
Shearing, side trimming, and slitting equipment 34
Siding construction, railroad 191
Slitting lines 14
Soaking pits, circular 9
Steam jets 193
Steel plant, construction of 12, 222
Straightening machines 157
Switch, disconnecting 140
Switch, motor-starting ..... Cover IV
Switchgear 27, 142

Terminators 218
Tool steel, alloy 149
Transformers 171, 216
Trucks, industrial 203
Tuyeres, blast furnace 192

Valves, constant flow oil 166
Valves, flanged 164
Valves, hydraulic 158

Wires and cables, insulated 32, 155, 161, 227

IRON AND STEEL ENGINEER — September, 1948

Please send me additional products information as requested below:

Product and Page No .....

" " " " .....

" " " " .....

Name .....

Title or Position .....

Company .....

Address ..... City ..... Zone .... State .....

Postage Will be Paid by Addressee

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

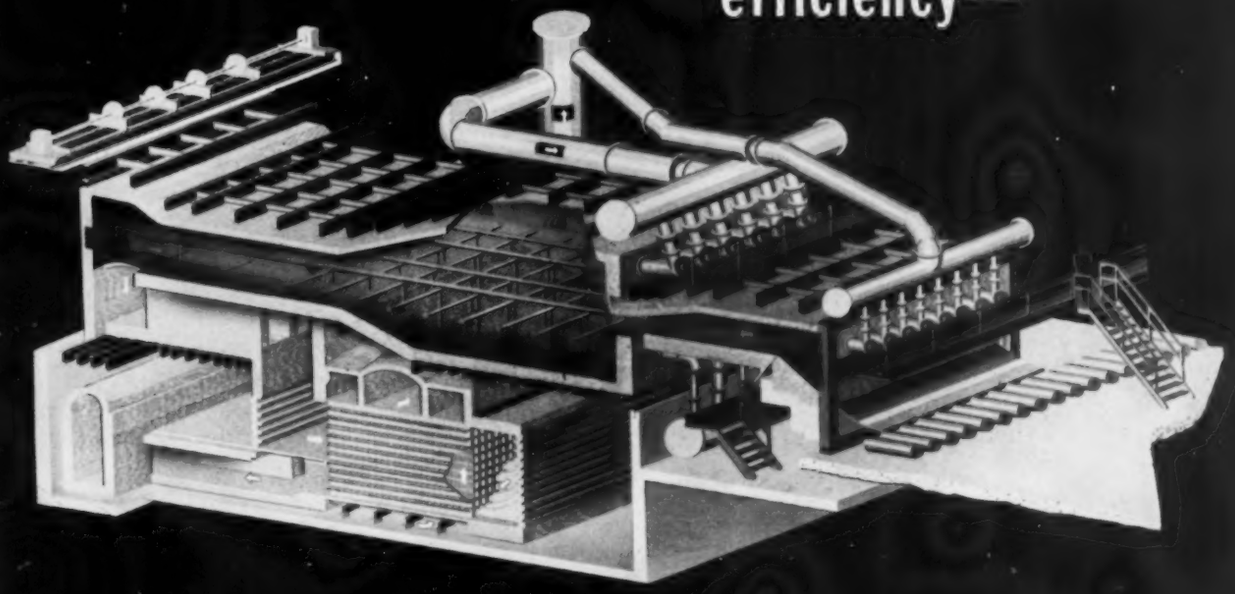
First Class Permit No. 1963, Sec. 510 P.L.&R. Pittsburgh, Pa.

IRON AND STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.

There's only one way to assure heating efficiency—



LOOK INTO

RUST *ZONE-CONTROLLED* CONTINUOUS FURNACES

for reheating blooms, slabs, billets, bars . . .

ONLY ONE TYPE of continuous furnace provides perfect control of the heating operation from start to finish. That's the Rust Zone-Controlled Recuperative Continuous Furnace with independently fired heating and soaking chambers. Built in tandem, they assure control of tonnage output, heating quality and 100% accuracy in control of predetermined heating temperatures.

Roof design at charging end of heating chamber allows for expansion, thus reduces velocity and eliminates bleeding of waste gases. Flexibility of output is achieved by changing rate of fuel fired. Soaking chamber heat remains constant for any specific rolling temperature, gives uniform heat distribution with a minimum of fuel. Consult a Rust expert now on Double and Triple-Fired type furnaces for heating light and heavy sections.

RUST FURNACE CO.
PIONEERS IN FURNACE DESIGN
PITTSBURGH, PENNSYLVANIA

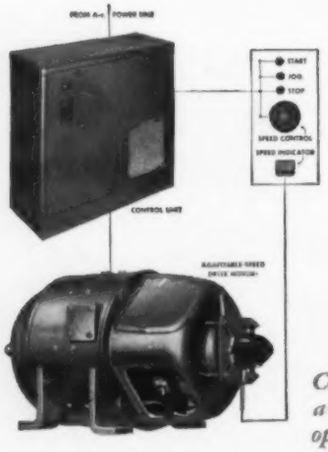
THE WHOLE JOB IS ONE JOB WITH A RUST "PACKAGE" CONTRACT

One Rust contract covers everything . . . from blueprint to test-run. Rust assumes responsibility for design, manufacture and erection of all essential material . . . including not only excavations, foundations and wiring, but all work connected with tables, pushers, controls and other equipment. Your purchasing and engineering departments are freed of subcontractor headaches when you order from Rust.

RELIANCE V★S DRIVE *Proved* . . . *in*

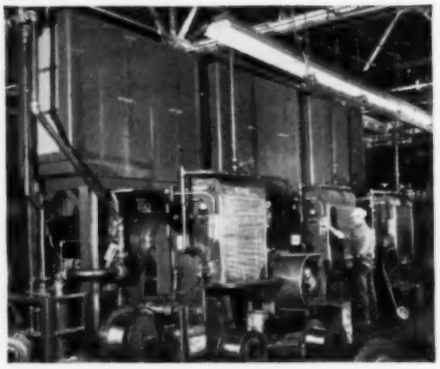
Today, thousands and thousands of Reliance V★S Drives, providing *adjustable speeds from A-c. circuits,* are helping to increase production and reduce costs in every industry. These completely packaged, all-electric drives have become so popular since they were first introduced ten years ago that there is now no important industry where they are not being profitably employed. If you do not yet have the proved time-saving and cost-cutting advantages of Reliance V★S Drive in your plant, it will pay you to investigate further. Write for *new* Bulletin 311!

Sales Representatives in Principal Cities



Conveniently-packaged, factory-wired V★S Drives are available from 1 to 200 hp. Two or more motors may be operated simultaneously from a single Control Unit.

METALS



PRINTING

RELIANCE ELECTRIC AND ENGINEERING CO.

1084 IVANHOE ROAD • CLEVELAND 10, OHIO

"Motor-Drive for More Than Power"

for 10 Years

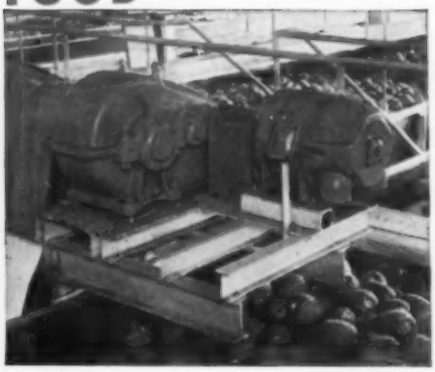
RELIANCE V★S DRIVE

Industry after Industry!

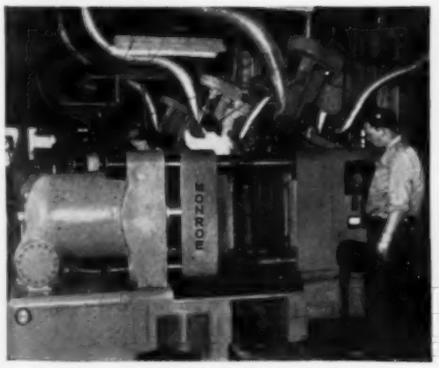
PAPER & BOARD

TEXTILE

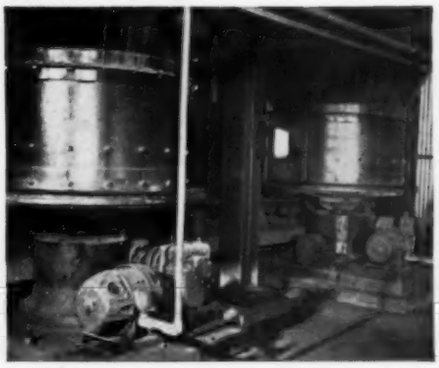
FOOD



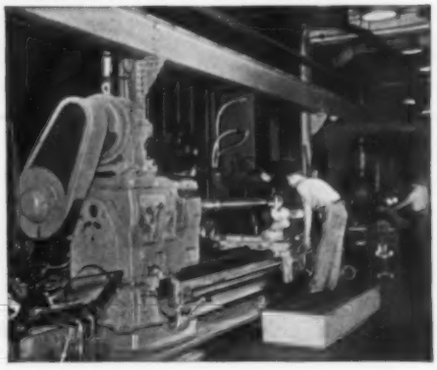
RUBBER



MINING



MACHINE TOOL



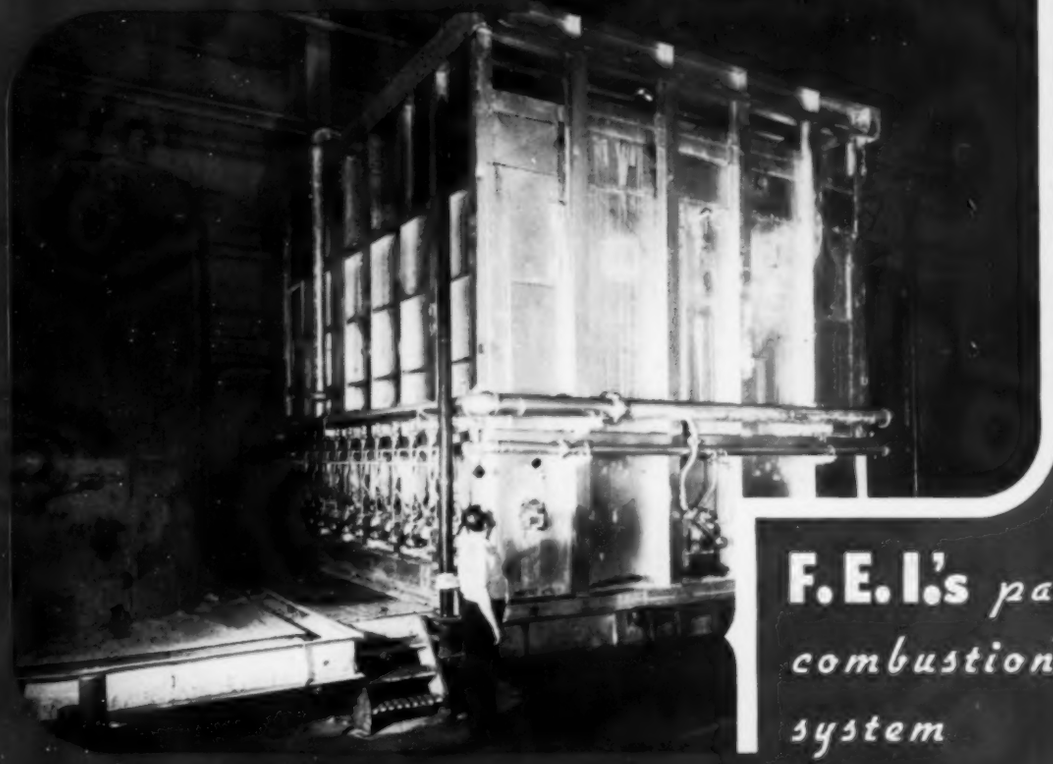
RELIANCE ELECTRIC AND ENGINEERING CO.

1084 IVANHOE ROAD • CLEVELAND 10, OHIO

"Motor-Drive for More Than Power"

Solving rolling mill puzzles is our specialty
FARREL
For almost a century Farrel engineers have specialized in rolling mill equipment, designed to solve specific production problems.
Mills are built in a wide range of types and sizes for rolling nonferrous rods, strips or sheets, metal foils and cold strip steel. The company also designs and manufactures the reduction gear drives and pinion stands, coilers and special handling equipment required to make each installation a complete production unit.
Another puzzle solver is the Farrel roll grinder. Available in two types and nine standard sizes, these machines enable you to fix and maintain definite standards of accuracy and finish. Rolls are produced with a perfect surface, free from marks of any kind, ground straight, or with concave or convex contours of exact symmetry and accuracy.
Information and engineering consultation available, without obligation.
FARREL-BIRMINGHAM CO., INC. • ANSONIA, CONN.
Plants: Ansonia and Derby, Conn.; Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston
FARREL
ROLLING MILL MACHINERY
Rolls • Rolling Mills • Rod Mill Tables and Manipulating Equipment • Universal Mill Spindles • Rod Coilers • Gears Mill Pinions • Pinion Stands • Gear Drives of any Capacity • Flexible Couplings Roll Grinding Machines • Roll Calipers Lead Presses for Pipe or Rod
FB-482
1848
FARREL
CENTENNIAL
1948
Farrel-Birmingham

basic fundamental of good heat treating



F. E. I.'s *patented combustion system*

F.E.I. *Builds*

For Blooming, Plate & Rolling Mills

Soaking Pits for all fuels.
Continuous Bloom, Billet and Slab Heating Furnaces.

Furnaces Equipped with F. E. I. Patented Combustion System

For Wire, Bar or Tube Mills

Galvanizing, Patenting or Normalizing Furnaces.
Cover Furnaces for bright annealing, heat treating, normalizing and spheroidizing of wire and rod products.

For Pipe, Sheet or Jobbing Plants

Hot Dip Galvanizing Furnaces.
Salt Bath descaling furnaces for stainless steel sheet, bar and other products.

Strip Mills

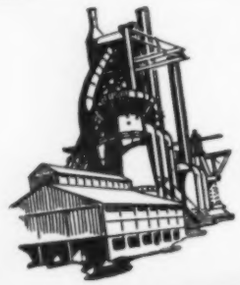
Direct fired Cover Furnaces for flat sheet and coil annealing, utilizing a patented base assembly.

CONSULT WITH US ON YOUR SPECIAL HEATING PROBLEMS

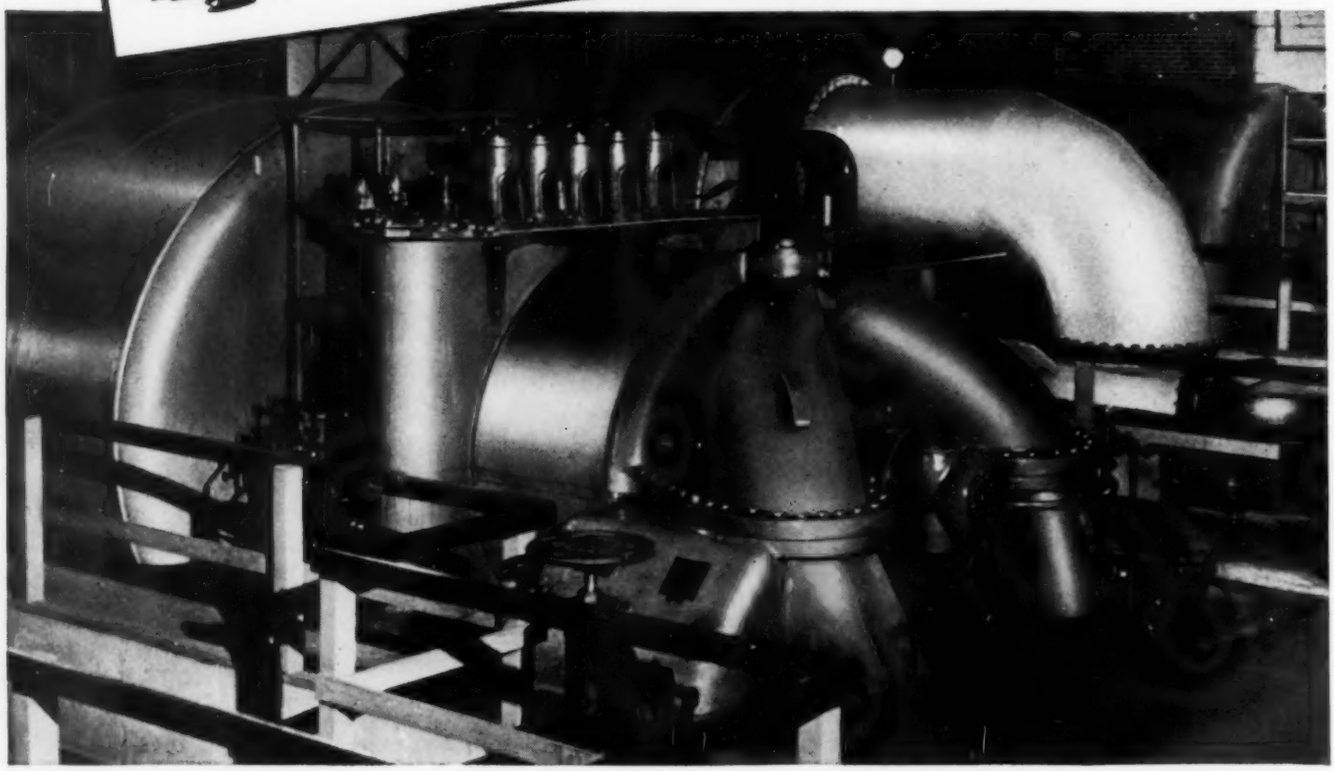
FURNACE ENGINEERS, *Inc.*

Representation in all Foreign Countries.

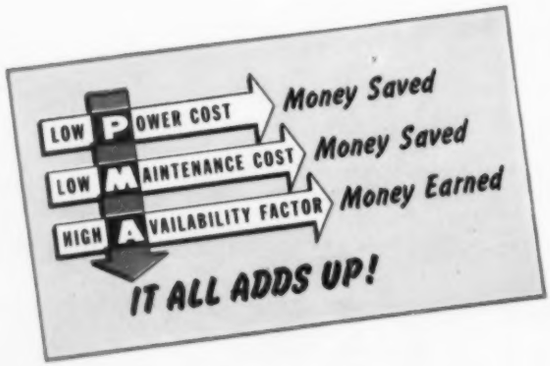
1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.



High Pressure Blast Furnace Blowing



with I-R BLOWERS



Although high pressure blowing is still in the pioneering stage, it may prove to be one of the most significant advances in blast furnace operation in recent years. Two standard Ingersoll-Rand turbo-blowers provided the air blast for this experimental work in high top pressure blowing and results have shown a substantial increase in pig iron production and a decrease in coke requirements per ton of pig iron produced.

This is just one of many recent installations that illustrate the way Ingersoll-Rand blower engineering has assisted in the development of better ways to produce iron and steel. If there is any way in which our engineers can assist you with a blower problem, don't hesitate to get in touch with the nearest Ingersoll-Rand office.

AIR TOOLS • COMPRESSORS • ROCK DRILLS •
CENTRIFUGAL PUMPS • TURBO BLOWERS
OIL & GAS ENGINES • CONDENSERS

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y. 226-12

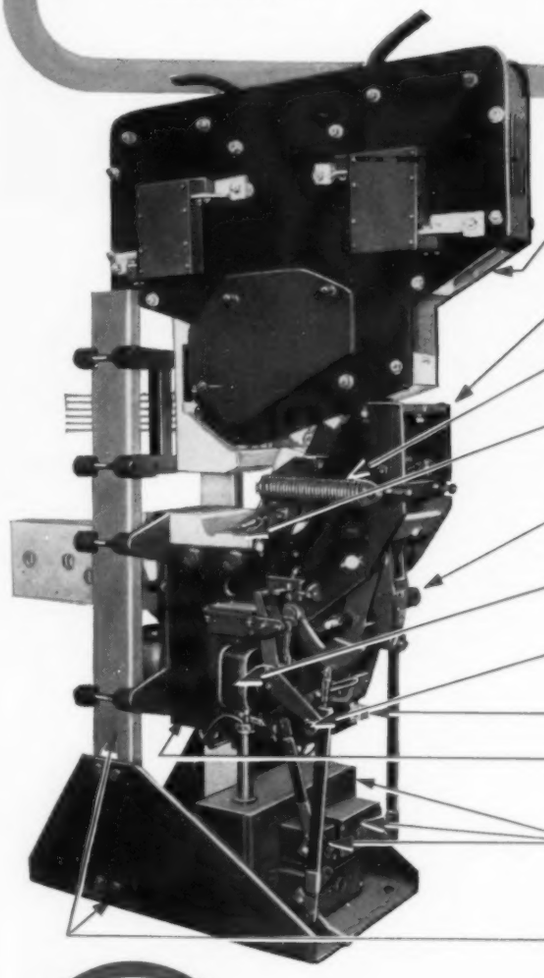
PROTECT VITAL PRODUCTION EQUIPMENT WITH THIS *Better designed-Better built* BREAKER

Short circuits and the extremely heavy overcurrents encountered in electrical distribution systems of Rolling Mills and Electrolytic plants can ruin essential generators, motors, rectifiers, and related equipment. This, and the resultant production shutdowns, and repair or replacement bills, cut deep into operating profits. I-T-E—specialists in quality Switchgear—give you *more effective, more dependable* protection from electrical disturbances with the better engineered Type MT Circuit Breaker.

Especially developed for interrupting extremely heavy direct-currents, the MT breaks a circuit in .028 seconds, (about 1¾ cycles on a 60 cycle basis) at 25% to 100% of interrupting capacity. Short circuits and overcurrents are cleared instantly, dependably. The MT is a single pole, electrically operated, D-C breaker designed for 250 and 750 volt service. Interrupting rating is 150,000 Amp. for 2000 and 4000 amperes continuous ratings, and 250,000 Amp. for models continuously rated 6000, 8000, 10,000 and 12,000 amperes. Further information on the MT is contained in catalog 2201. Send for it today.

The I-T-E representative in your locality will be glad to advise you on applying the MT—and other I-T-E protective equipment—to your electrical distribution system. Use his services without obligation.

NOTE THESE RUGGED, EFFECTIVE CONSTRUCTION FEATURES OF THE MT



MAGNETIC ARC CHUTE of large thermal capacity drives gas and arc upward for safe extinction. Arcing time is extremely short with either light or heavy currents.

SELF-ENERGIZING BUFFER MECHANISM smoothly absorbs shocks of opening—prevents sticking or bouncing.

HEAVY-DUTY OPENING SPRINGS are mechanically loaded while breaker is closed. Trip devices act directly on holding toggle for instantaneous opening.

LOWER STATIONARY MAIN CONTACT BLOCK—Main contacts are silver base inserts backed with solid blocks of copper. Silver base inserts assure contacts free from oxidation and overheating.

SIMPLE MECHANICAL SYSTEM includes a light-loaded roller-bearing latch for low friction and fast tripping.

SHUNT TRIP COIL allows remote electrical opening—by hand, by a relay, or by auxiliary switch on another breaker.

HAND TRIP BUTTON is provided to allow normal opening of the circuit at the breaker.

OPERATION COUNTER mounted on each breaker as a standard device.

CLOSING SOLENOID HOUSING—Metal enclosure protects the closing coil against corrosive mill atmosphere.

ACCESSORY DEVICES—Terminal box for control wiring, and multi-contact auxiliary switches for shunt trip coil and signal lamps, are conveniently located near base of breaker with ample space for control wiring.

SUPPORTING POST AND FABRICATED STEEL BASE—Entire frame of hot-rolled steel, formed and welded into a rugged, protective support unit.

I-T-E R&IE*

MILL TYPE SWITCHGEAR

The Leader In Technical Excellence

I-T-E CIRCUIT BREAKER CO., 19TH & HAMILTON STREETS, PHILADELPHIA 30, PA.—31 OFFICES IN UNITED STATES
IN CANADA, I-T-E IS EASTERN POWER DEVICES LTD., TORONTO

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS • HIGH SPEED CIRCUIT BREAKERS

**FOR POWER SWITCHING EQUIPMENT, REFER TO RAILWAY AND INDUSTRIAL ENGINEERING CO., AN I-T-E ORGANIZATION*

new, individual-generator drive on world's fastest strip mill gives increased flexibility, more "on-gage" tonnage!

engineered drive provides automatic speed adjustment between stands, constant strip tension, and accurate gage control—at 6200 fpm!

Seventy miles per hour! That's the record speed of a new G-E - equipped tandem cold-strip tinplate mill. To this fastest and heaviest mill of its kind in the world, the new G-E individual-generator drive brings increased flexibility and simplicity of operation, higher permissible rates of acceleration and deceleration, and a greater percentage of "on-gage" strip.

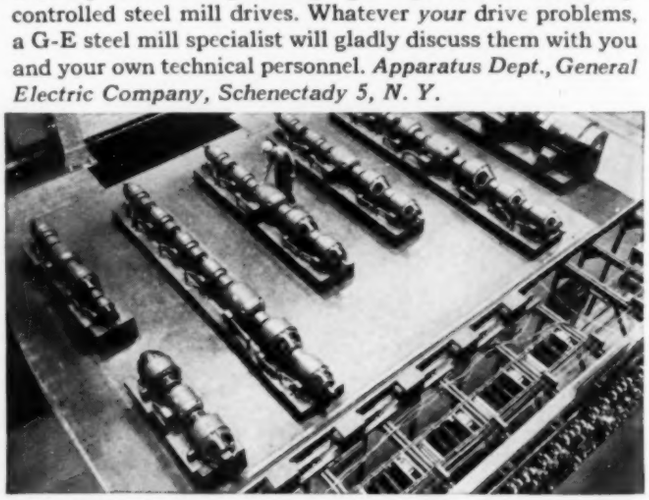
Widens Speed Range. By providing a separate generator for each drive motor, this improved drive eliminates the need for costly high-current series boosters and permits generator voltages to be adjusted independently of each other, thus widening the speed range of each stand.

Adjusts Tension Automatically. To hold proper speed relationship at all times between the stand motors, ohmic-drop compensation is provided by the G-E amplidyne. This electric "brain" automatically adjusts strip tension during acceleration and deceleration, thereby preventing strip breakage, possible damage to the mill rolls, and added scrap. The mill gets "on gage" faster, stays "on gage" longer.

Measures Gage by X-Ray. An X-ray thickness gage is another feature of the new drive. This unique device, without physical contact, continuously measures the finished strip's thickness, further insuring gage accuracy. In addition, tensiometers provide a continuous visual indication of strip tension.

Harnesses 16,800 hp. Six G-E drive motors have a total capacity of 16,800 hp. Use of twin drive motors on the last three stands prevents slippage between rolls and material, making for uniform strip quality and longer roll life.

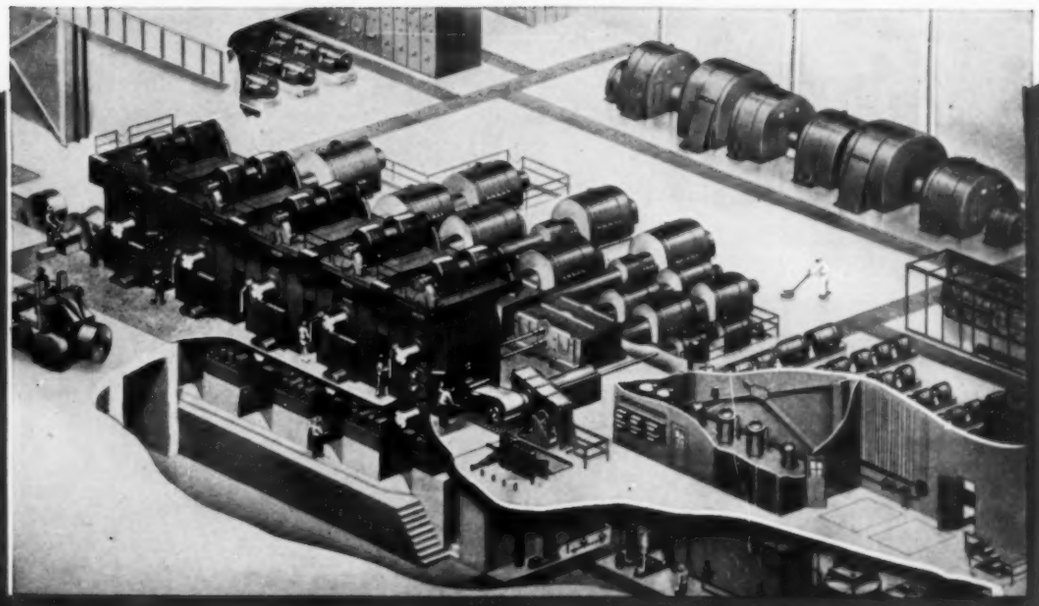
This individual-generator drive and its components, installed as a unit, is another example of General Electric's wide experience in engineering higher-speed, more accurately controlled steel mill drives. Whatever *your* drive problems, a G-E steel mill specialist will gladly discuss them with you and your own technical personnel. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



With G-E amplidynes, shown above, the new mill can be accelerated from a 300-fpm threading speed to over 4500 fpm or decelerated from 6200 fpm to a dead stop—in only 6 seconds!

GENERAL ELECTRIC

659-53



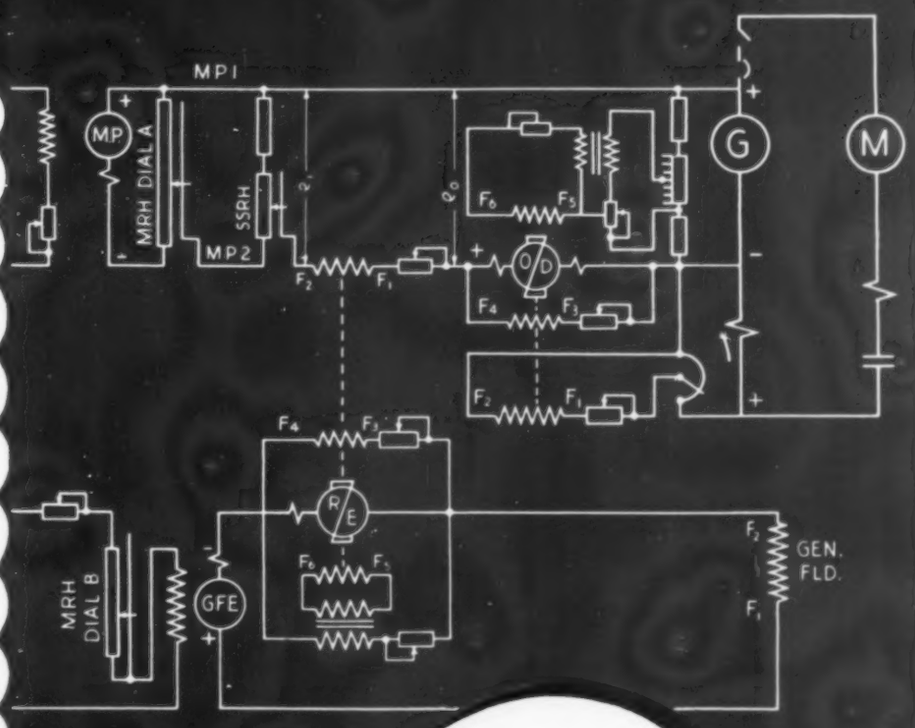
Complete electric equipment supplied by G-E for this 42-inch, 5-stand tandem cold-strip mill includes main driving motors (center), main m-g sets (rear), screw-down mg set and 440-volt power distribution (left background), auxiliary m-g set and main control board (right foreground).

Here is how individual-generator control works on a single mill stand

In the control circuit shown on the right, the mill master rheostat determines the voltage on the master voltage-control bus MP1 and MP2, which is the standard by which the voltage on every generator is controlled. By raising or lowering the voltage on this bus, the voltages of all the generators may be raised or lowered proportionately. The mill master rheostat also controls the excitation on the generator-field exciter GFE which supplies all stand generators. In this way, regulating exciters RE on each stand can operate at low voltage levels ideal for fast regulator action.

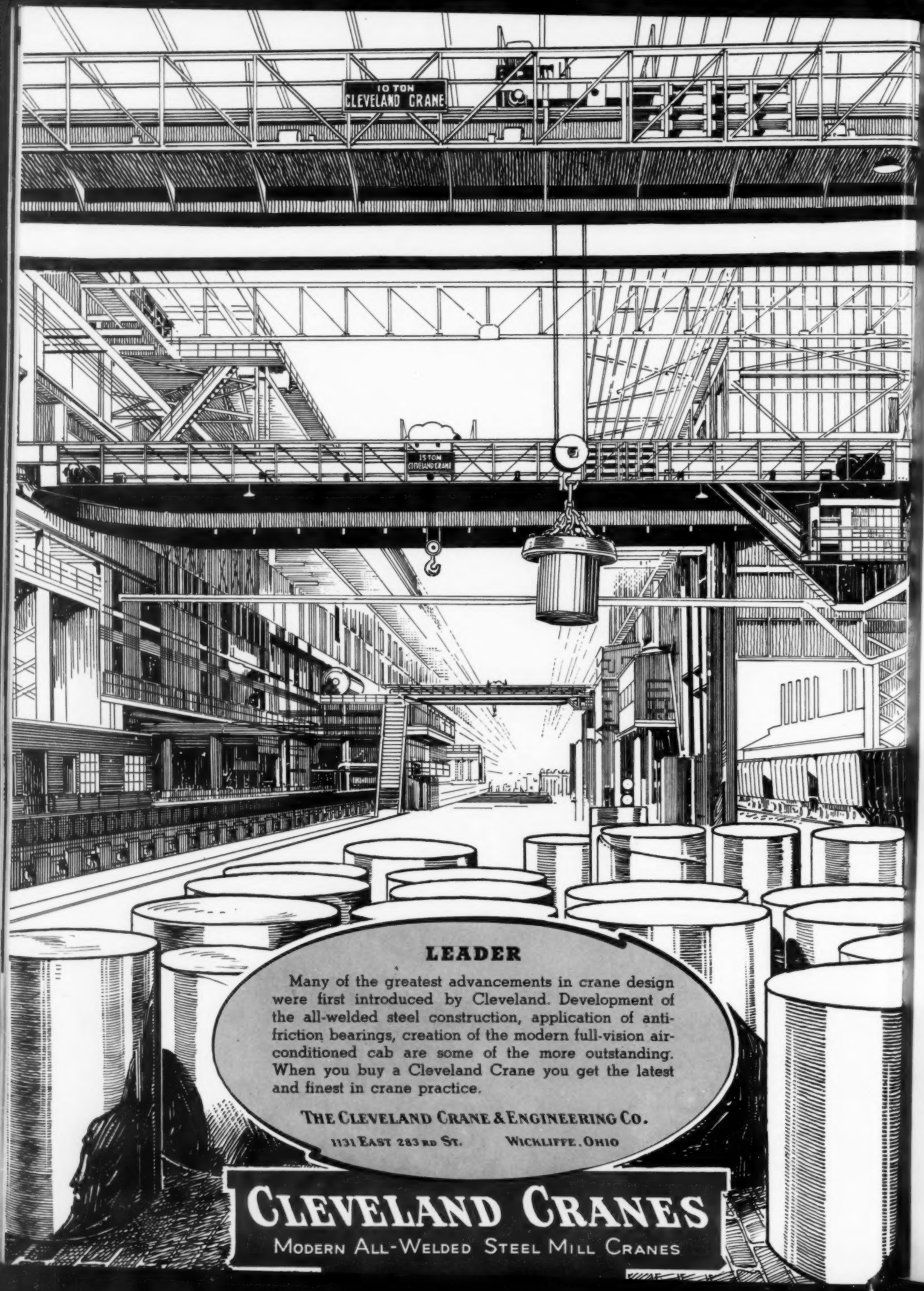
Individual voltage adjustment on each generator is determined by the stand master rheostat. Each stand-motor speed can also be controlled by adjustment of its shunt-field current.

The ohmic-drop exciter OD receives its excitation from the voltage drop across the generator commutating field, and its output voltage may be made equal to (or any fixed percentage of) the motor-armature-circuit IR drop. The voltage of this amplidyne is automatically subtracted from the generator terminal voltage. Each stand regulator, through its regulating exciter RE, then acts to hold essentially motor cemf which is directly proportional to motor speed.



another example of

drive engineering at work!



LEADER

Many of the greatest advancements in crane design were first introduced by Cleveland. Development of the all-welded steel construction, application of anti-friction bearings, creation of the modern full-vision air-conditioned cab are some of the more outstanding. When you buy a Cleveland Crane you get the latest and finest in crane practice.

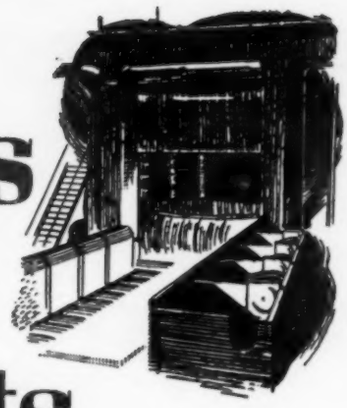
THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE. OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts



STEEL price increases of approximately $30 per ton recently announced by Kaiser Company puts its prices considerably above those of any other producer. It is claimed that these increases are necessary because of the high investment cost for the plant. Some authorities believe that the move was made in the hope that protests from steel users might lead RFC to reduce the mortgage it holds against the plant. Be that as it may, but the fact remains that the consumers must pay more for their steel.

This same condition would arise to some degree if steel companies were to build a lot of new plants under present conditions. Yet that is exactly what the government is asking the industry to do.

▲

THERE is some talk that the government might build several steel plants to expand the country's capacity, probably leasing them for operation to various steel producers. If the lease price would be right, this would be one way of relieving the producers of the burden of the excessive investment necessary under present conditions. If the new plants were strategically located, it might also give the lessors some advantage under the new f.o.b. mill pricing.

▲

DISLOCATIONS due to the new pricing system continue to be secondary to the question of how to get more steel. Steel users have kept the heat on Washington until the Senate's Small Business Committee visited several of the steel companies to see where the steel is going. At some future date, when the market swings more to the buyer's favor, the heat will probably be on Washington to do something about pricing — and it will probably take such pressure to bring about a change.

Meanwhile, the steel industry is feeling its way along several lines. Some companies are considering establishing warehouses in major consuming territories. Others are helping customers investigate the possibilities of moving their plants close to the steel mills.

▲

BERNARD Baruch stated a very universal feeling when he observed: "To me, old age is always 15 years older than I am."

▲

PRESENT arguments as to the steel capacity needed in the United States to take care of future needs center around three forecasts. B. B. Smith, United States Steel Corporation economist, sees a normal requirement of 60-70 million tons of ingots per year, or approximately 900 lb per capita. Wilfred Sykes, president of Inland Steel Company, has set the figure at 1100 lb per capita, or 76-80 million tons per year. L. H. Bean, of the U. S. Department of Agriculture, sees a need of more than 100 million tons per year (approximately 1400 lb per capita) by 1950. This range of figures probably contains both undue optimism and undue pessimism. Personally, we incline toward the middle figure.

▲

ACCORDING to National Safety Council statistics, the 1947 safety record of the steel industry was the best in its history. The frequency rate of 6.08 injuries per million man-hours worked and the severity rate of 1.60 days lost per 1000 man-hours worked are all-time lows for the industry, and place it third in frequency and twenty-eighth in severity among 40 major industries.

▲

SOME vacation definitions:

A short duration of recreation, preceded by a period of anticipation and followed by a period of recuperation.

Two weeks which are too short, after which you are too tired to work and too broke not to.

▲

INTEREST continues to grow in secondary recovery of oil from wells that have apparently run dry. It is estimated that approximately 25 per cent more oil can be obtained from fields that have stopped producing. Methods used for further recovery are repressurizing by pumping natural gas back into the oil sands, or by flooding the sands with water. This practice will materially increase our known oil reserves, which are now estimated at 21.5 billion barrels.

▲

ACCORDING to the American Iron and Steel Institute, Stalin's objectives for the Russian steel industry in 1950 are annual capacities of 40,000,000 tons of iron ore, 30,000,000 tons of coke, 19,500,000 tons of pig iron, and 25,400,000 tons of steel. The United States capacities were higher than those figures 35 years ago, and at present, they are 2½ to 3 times as great.

▲

FROM the Houghton Line:

Sign on a plumber's shop window: "If I am out, arrange dates with my wife."

Hospitality has been defined as the art of making guests feel at home when you really wish they were.

It's hard to figure out why a girl thinks a man is rude and vulgar when he stares at what she's trying so hard to display.

▲

THE responsibility for the high cost of living is currently being tossed around like the proverbial hot potato, but the fact remains that our federal government will lay out about $2,000,000,000 this year to support farm prices. Some of this will be a dead loss. Some non-perishables may be held indefinitely, and eventually sold to realize something on the expenditure.

Among products the government is buying are wheat, cotton, corn, eggs, potatoes, dried fruit, tobacco, peanuts, barley, oats, rye, dry beans and peas, rice, wool, sugar beets, turpentine and flaxseed. Do you folks see any item in this list that you have found to be too cheap lately?

ONLY TIME-TESTED INSULATION STABILITY ASSURES **LONG LIFE** IN VARNISHED CAMBRIC CABLE

Varnished Cambric switchboard wire (flameproof braid)
V. C. Cable with interlocked armor for indoor use (Type ACV)
Three conductor V. C. Cable with lead sheath

...and long time heat runs *PROVE* stability of Okonite V. C. cables

NOTHING takes the place of time in testing varnished cambric cable insulation. That's what Okonite engineers have found from experience. And that's why they haven't relied on accelerated aging tests alone.

So, after these conventional proof tests on materials, Okonite further checks results by exposing factory-made lengths of finished cable in a constant-temperature chamber . . . maintaining them there at 100 degrees C for months — even years . . . taking test results at periodic intervals . . . creating conditions more severe than field service.

Okonite varnished cambric insulation has high dielectric strength and low dielectric loss at high temperatures. The use of Verticol, Okonite's non-migrating, moisture-resistant insulating compound, contributes substantially to its electrical stability.

Okonite varnished cambric cables permit high operating temperatures, allowing heavy current loading . . . are easy to splice and handle . . . are available in all sizes and for use up to 28,000 volts. For a detailed description of Okonite's entire varnished cambric line with illustrations, tables and current carrying capacities, write for a copy of Bulletin 1S -1013. Address The Okonite Company, Passaic, New Jersey.

With today's installation costs* only the *Longest-Lived* will be economical

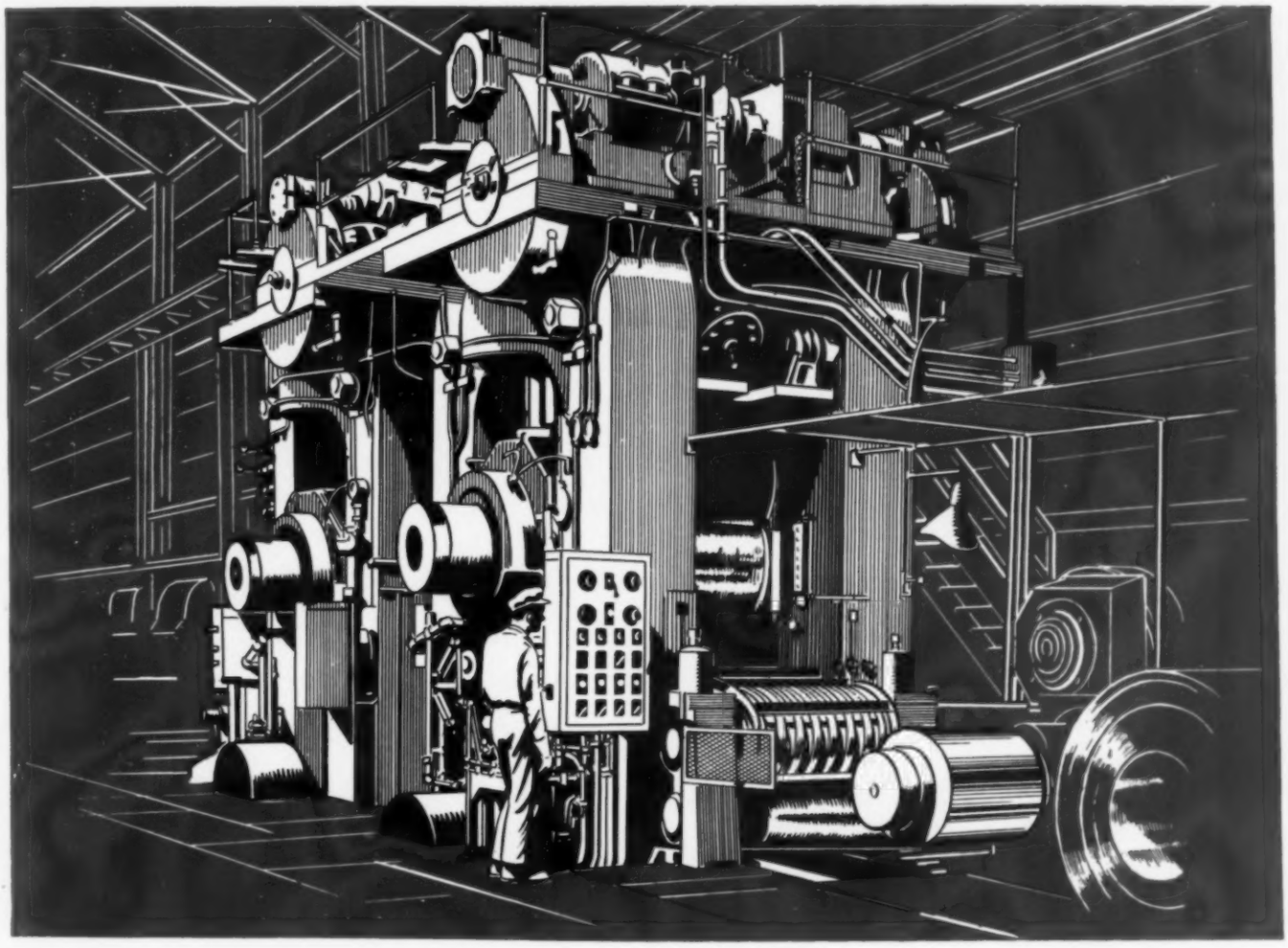
The lifetime cost of a cable rather than its first cost is the only true measure. Okonite wires and cables, made to stand up better and last longer, can offset high installation costs.

6848

OKONITE insulated wires and cables

THE BEST CABLE IS YOUR BEST POLICY

YES! Tycol Apreslube Lubricants perform better . . . BETTER . . . BETTER



Tycol Apreslube Lubricants perform better because:

. . . *Tycol Apreslubes* are extreme pressure lubricants that stand up under severe heat and moisture conditions, under tremendous loads.

. . . *Tycol Apreslubes* are highly stable, will not separate while in storage or service. They inhibit against corrosion even in presence of water.

. . . *Tycol Apreslubes* mean lower lubrication costs . . . longer service life for your equipment.

. . . *Tycol Apreslubes* never thin unduly at high temperatures. They guard against overheating and excessive wear in gears and bearings.

Your nearest Tide Water Associated Office is ready to help you select that Tycol Apreslube lubricant best suited for your particular need. Call or write today.

TYCOL

INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Pittsburgh • Philadelphia
Chicago • Detroit • Tulsa
Cleveland • San Francisco

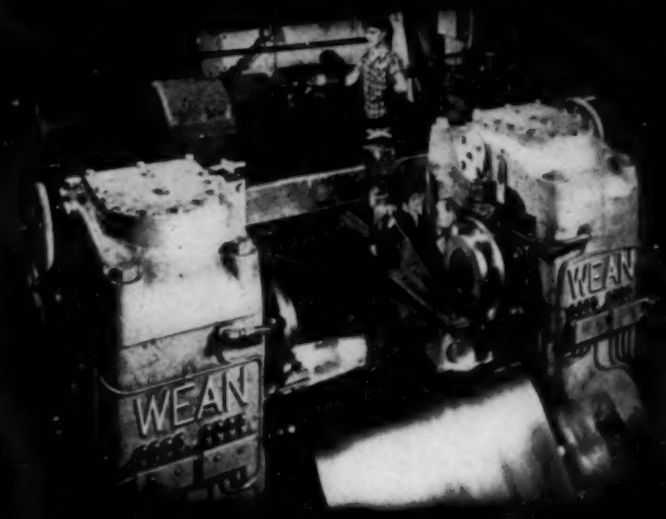
TIDE WATER ASSOCIATED OIL COMPANY

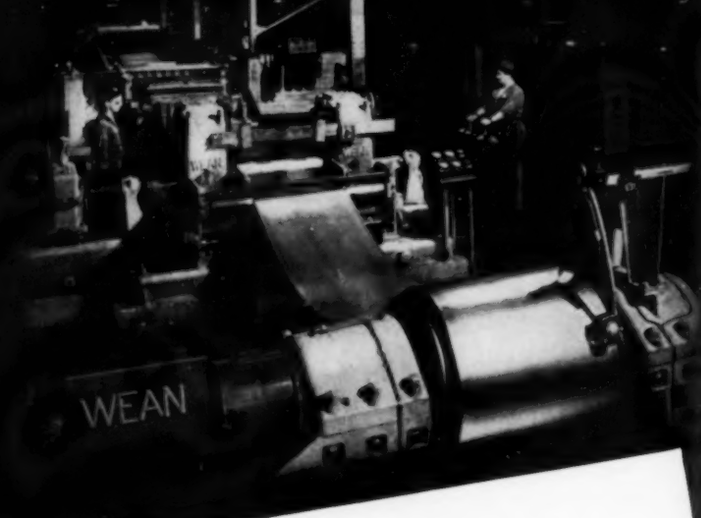
17 BATTERY PLACE · NEW YORK 4, N. Y.

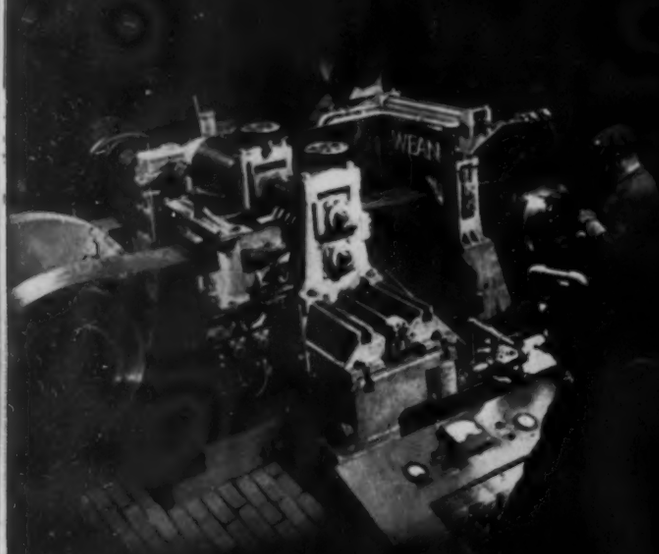
LUBRICATION — "ENGINEERED TO FIT THE JOB"

WEAN

SHEARING, SIDE TRIMMING AND SLITTING EQUIPMENT *for* STRIP STEEL







THE WEAN ENGINEERING CO., INC.
WARREN, OHIO

...ES IN SHEET, STRIP AND TIN MILL EQUIPMENT

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
ALBERT W. ERICKSON, JR., *Production Manager*

Board of Directors

PRESIDENT
A. J. FISHER
Assistant Chief Engineer of Construction
Bethlehem Steel Company
Bethlehem, Pennsylvania

1ST VICE PRESIDENT, G. H. WILLIAMS, *Chief Engineer,* Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

2ND VICE PRESIDENT, A. S. GLOSSBRENNER, *Assistant Vice President of Operations,* Youngstown District, Youngstown Sheet and Tube Company, Youngstown, Ohio.

TREASURER, JOHN F. BLACK, *General Superintendent,* Colorado Fuel and Iron Corporation, Wickwire-Spencer Steel Division, Buffalo, New York.

SECRETARY, I. N. TULL, *Electrical Superintendent,* Republic Steel Corporation, Cleveland, Ohio.

PAST PRESIDENTS: FREEMAN H. DYKE, *Assistant General Manager,* Wheeling Steel Corporation, Steubenville, Ohio.

J. L. MILLER, *Assistant Chief Combustion Engineer,* Republic Steel Corporation, Cleveland, Ohio.

HONORARY DIRECTORS: JAMES FARRINGTON, *Electrical Superintendent,* Wheeling Steel Corporation, Steubenville, Ohio.

WALTER H. BURR, *Electrical Superintendent,* Lukens Steel Company, Coatesville, Pennsylvania.

CHARLES L. McGRANAHAN, *Assistant General Superintendent,* Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

DIRECTOR AT LARGE, J. L. YOUNG, *Vice President of Engineering,* National Tube Company, Pittsburgh, Pennsylvania

DIRECTORS: WALTER NIELSEN, *Superintendent Blast Furnace,* Sloss-Sheffield Steel and Iron Corporation, Birmingham, Alabama.

R. W. GRAHAM, *Electrical Superintendent,* Bethlehem Steel Company, Lackawanna, New York.

W. J. TUNNY, *Assistant Electrical Engineer,* Youngstown Sheet and Tube Company, East Chicago, Indiana.

E. C. McDONALD, *Combustion Engineer,* Republic Steel Corporation, Cleveland, Ohio.

J. A. SHIMMIN, *Superintendent of Maintenance,* Rotary Electric Steel Company, Detroit, Michigan.

C. R. HAND, *Assistant Superintendent of Mechanical Department,* Bethlehem Steel Company, Sparrows Point, Maryland.

ERIC L. ANDERSON, *Electrical Superintendent,* Bethlehem Steel Company, Johnstown, Pennsylvania.

M. B. ANTRIM, *Electrical Engineer,* Lukens Steel Company, Coatesville, Pennsylvania.

R. E. BOBBITT, JR., *Chief Engineer,* Atlantic Steel Company, Atlanta, Georgia.

C. W. BRUCE, *Assistant Chief Engineer,* Republic Steel Corporation, Chicago, Illinois.

J. H. VOHR, *Assistant General Superintendent,* Carnegie-Illinois Steel Corporation, Chicago, Illinois.

D. N. EVANS, *Assistant Master Mechanic,* Inland Steel Company, East Chicago, Indiana.

ANDERS G. ERICSON, *Chief Engineer,* Homestead Works, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania.

Managing Director
T. J. ESS
Empire Building
Pittsburgh, Pennsylvania

Iron AND Steel ENGINEER

SEPTEMBER 1948 VOLUME XXV NUMBER IX

In This Issue

Submerged Arc Welding for Maintenance — by C. C. Keyser, Welding Engineer, Bethlehem Steel Company, Steelton, Pennsylvania 37

Principles of Job Scheduling in a Machine Shop — by L. E. Fuller, Jr., Assistant General Foreman, Machine Shop, Carnegie-Illinois Steel Corporation, South Works, Chicago, Illinois 43

Preventive Maintenance — by E. L. Anderson, Superintendent, Electrical Department, Bethlehem Steel Company, Johnstown, Pennsylvania .. 55

Rehabilitation of Existing Pipe Lines — by Alfred B. Anderson, Chief Engineer, Water and Sewer Division, Pittsburgh Pipe Cleaner Company, New York, New York 57

Safety in Maintenance and Construction — by Dan Farrell, Supervisor of Safety, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania 60

Republic Expands Stainless Finishing Capacity 62

Industrial Truck Storage Battery Maintenance — by R. E. Miller, General Foreman, Sheet and Tin Division, Bethlehem Steel Company, Sparrows Point, Maryland 64

Roll Turning with Carbide Tools — by F. R. Dinger, Kennametal, Inc., Latrobe, Pennsylvania 66

Republic's New 48 In. Mill at Youngstown, Ohio — by T. J. Ess 69

Official Program, AISE Annual Convention and Iron and Steel Exposition 72

Authors and Chairmen, 1948 AISE Convention 75

Abstracts of Papers to be presented at Annual AISE Convention 81

Iron and Steel Exposition Floor Plan 93

List of Exhibitors 94

Steel Plant Service Requirements for Cranes — I. E. Madsen, Standards Engineer, Association of Iron and Steel Engineers 96

Lubrication Equipment Maintenance — by Robert A. Kraus, General Millwright Foreman, Republic Steel Corporation, Chicago, Illinois 100

Bearing Construction and Performance Characteristics — by E. Crankshaw, Assistant Chief Engineer and K. Scheucher, Assistant Chief Product Engineer, Cleveland Graphite Bronze Company, Cleveland, Ohio 109

Barium Lubricating Grease — by C. J. Boner, Chief Research Chemist and G. W. Miller, President, Battenfeld Grease and Oil Corporation of New York, Kansas City, Missouri 120

Twin-Motor Drives for Cold Mills — by R. H. Wright, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania 125

Selecting Materials to Reduce Maintenance — by W. H. Sparr, International Nickel Company, Inc., Pittsburgh, Pennsylvania 134

News Supplement 153

Personnel 181

Date Line Diary 220

Index to Advertisers 229

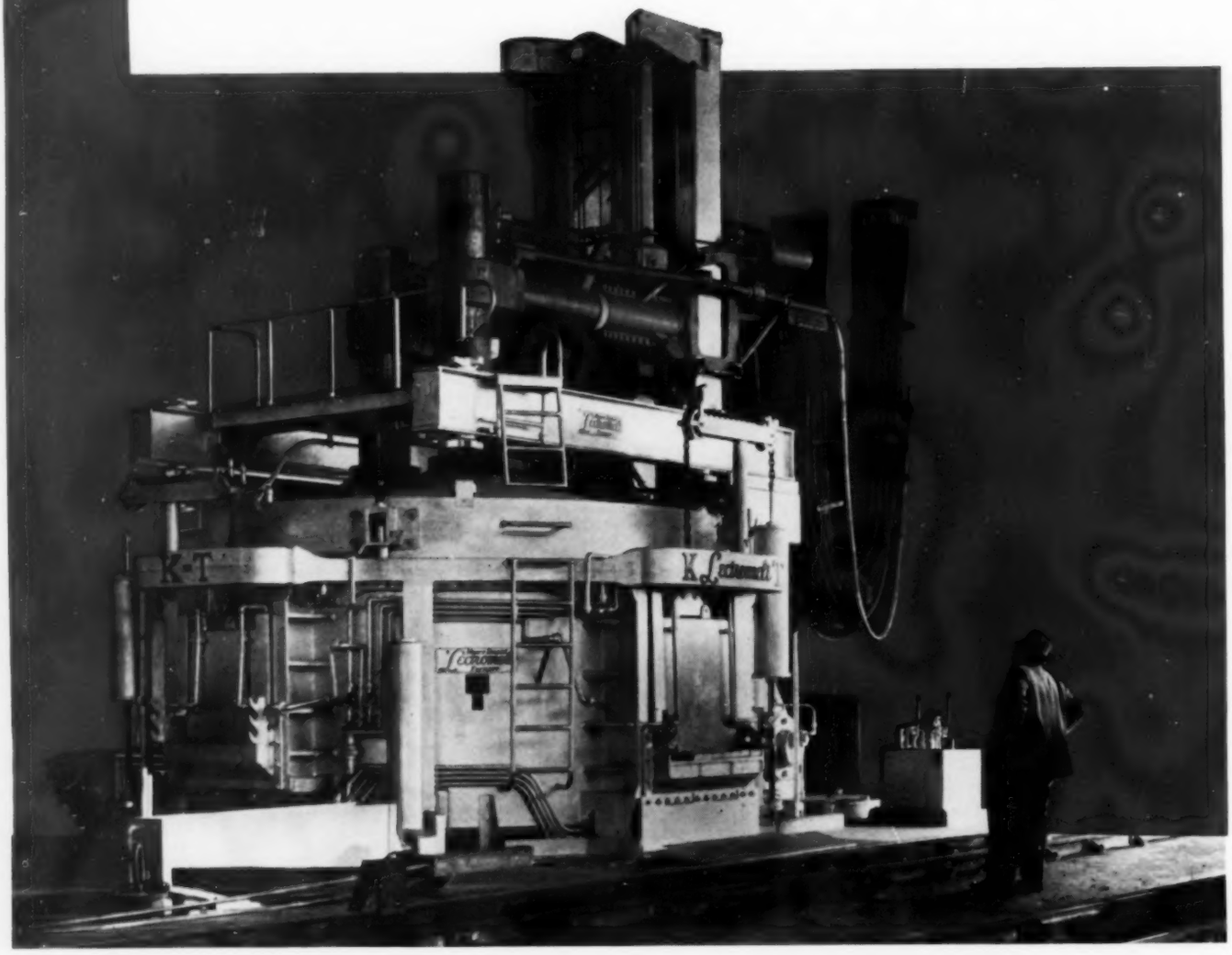
Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expression of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility. Copyright, 1948, The Association of Iron and Steel Engineers

Single Copy Foreign Prepaid $2.00 Single Copy $1.50
Subscription price in U. S. ..... $ 7.50 per year
Subscription price in Canada (U. S. funds) ..... $ 8.25 per year
Subscription price in foreign countries ..... $10.00 per year

PLASTIC BINDING U. S. PATENT NO. 1370285 LICENSE NO. 120

from **100 tons** *to* **25 pounds** *capacity*



MOORE RAPID

Lectromelt

FURNACES

famous the world over for speed, economy, dependability and flexibility in the melting and refining of iron, steel, nickel and copper.

Manufactured in

CANADA	Lectromelt Furnaces of Canada, Ltd., Toronto 2
ENGLAND, SWEDEN, AUSTRALIA	Birlec, Ltd., Birmingham, England
FRANCE	Stein et Roubaix, Paris
BELGIUM	S. A. Belge Stein et Roubaix, Bressoux-Liege
SPAIN	General Electric Espanola, Bilbao
ITALY	Forni Stein, Genoa

PITTSBURGH LECTROMELT FURNACE CORP.

PITTSBURGH 30, PENNSYLVANIA

Submerged Arc Welding

FOR MAINTENANCE

. . . . although welding is an old maintenance tool, developments in the art constantly expand the applications and economy of the process . . . .

By C. C. KEYSER, Welding Engineer
Bethlehem Steel Company
Steelton, Pennsylvania

▲ THE use of automatic welding in steel mill maintenance has been common practice for many years. With few exceptions this welding is done with lightly coated electrodes corresponding to A.W.S. Specification—Type E-4520. This electrode is generally available in three or four grades of plain carbon steel with a carbon range from 0.06 to 0.60 per cent. The deposited metal has a minimum tensile strength of 45,000 psi and 4 to 10 per cent elongation in 2 in. While these physical properties are satisfactory for some purposes, they leave a great deal to be desired. In no case is the deposited metal equal to the original material, and a piece repaired by automatic welding using this type of electrode is definitely inferior to a new one.

While a number of different methods have been devised for using shielded arc electrodes in automatic heads or producing automatic welds with the same physical properties as those produced by shielded arc electrodes, very little effort was made by either the manufacturers or the steel mills to apply these methods to maintenance work.

This condition can be explained in part by the fact that the first cost of most of this equipment is quite high and much of it, for one reason or another, is not practical for application to maintenance work.

About 2¼ years ago it was brought to our attention that the automatic welding head in our maintenance shop could be used for submerged arc welding simply by purchasing suitable wire and granular flux, and rigging some means of applying the flux on the work in the proper amount. We were supplied with a sample of wire and flux and after the first trial it was obvious the process had many possibilities and it was adopted immediately.

It was soon apparent that the operation of submerged arc process was much more critical and contained many more variables than the old process. For this reason one of the very best maintenance operators in the shop was assigned to the automatic welding machine. The value of this step continues to become increasingly apparent as more and more applications are found for this type of welding.

Presented before AISE Philadelphia District Section Meeting, April 3, 1948

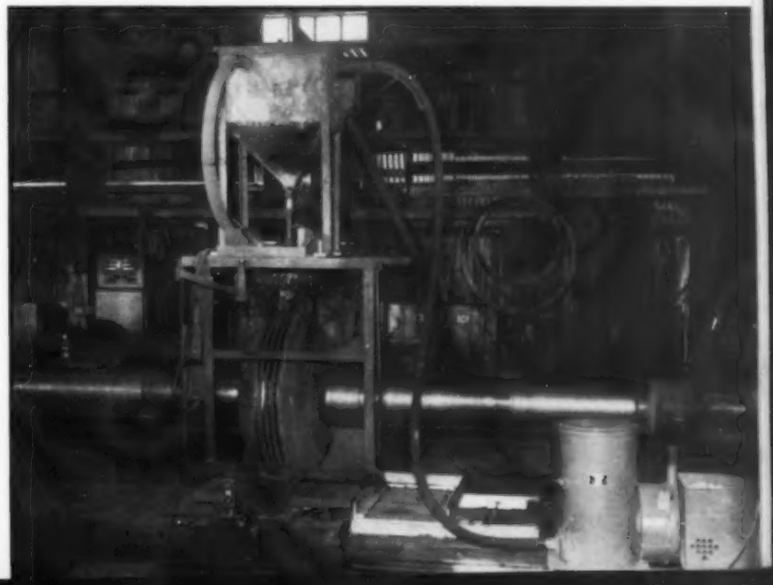
No attempt will be made to go into the details of developing the present equipment, but a brief description of our automatic welding set-up in use at the present time may be of interest.

The source of welding current is a 1250-ampere, constant-potential motor-generator set connected to the welding head through 2 resistance boxes, both of which are divided into two 300-ampere panels. The automatic welding load is generally carried by 3 of these panels connected in parallel, while the fourth panel is used for any hand welding that may be required, such as tacking or patching; however, this panel can also be connected to the welding head if necessary. The cooling air from the motor-generator set is also used for cooling the resistance boxes. All welding is done with straight polarity, electrode negative, with no provision for using reversed polarity.

The welding heads required no changes, but larger cables were installed so currents up to 700-amperes could be handled on a continuous basis.

A lathe capable of handling work up to 50 in. in diameter over the carriage and 26 ft long is used for turning the work. The lathe carriage upon which is mounted the

Figure 1 — The welding set-up including the welding head, flux hopper and vacuum machine are shown in this view.



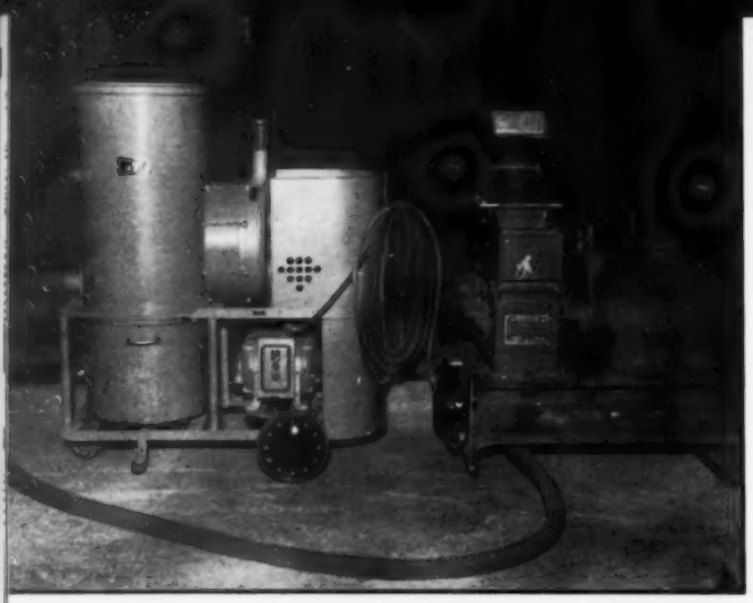


Figure 2 — Economies are available through reclamation of the flux, and the crusher and vacuum machine used for reclaiming the fused flux are here shown.

welding head, wire reel and flux hopper, is driven by a lead screw at the rate of ¼ or ⅜ in. per revolution of the work. The lathe is driven by a variable-speed d-c motor, which along with the gears gives a continuous speed range from one revolution in 15 minutes to one revolution in 1 minute and 15 seconds.

The flux recovery system consists of an overhead hopper with a flux capacity of 300 to 400 pounds. A partial vacuum is maintained in this hopper by a standard 5-hp flux recovery unit. Flux is delivered to the work from the bottom of the hopper by a flexible metal tube, picked up by a nozzle behind the arc and returned to the top of the hopper through a 2 in. sand blast hose. There is another hose leading from the catch pan under the work to the top of the hopper which is used to replenish the flux supply in the hopper and also to return whatever unfused flux may escape the regular nozzle. The only flux that enters the vacuum machine is the very fine material that passes the baffle plates in the flux hopper. The fused flux drops from the work to a screen over the catch pan. A general view of the welding head, flux hopper and vacuum machine is shown in Figure 1.

The fused flux is saved and put through a small hammer mill to crush it for use a second time. The crushing unit with the vacuum machine is shown in Figure 2. The crusher and motor are mounted on a channel iron base and fitted with a lifting lug to enable it to be moved by a crane. The vacuum machine is connected to the discharge end of the crusher. Thus a partial vacuum is maintained in the crusher, completely eliminating the dust problem while the crusher is in operation, and at the same time delivering the crushed flux into the container in the base of the vacuum machine.

There are still many questions to be answered concerning the use of reclaimed flux. From our experience to date it appears to be satisfactory in every respect when used with mild steel, but on high carbon or alloy steel bead cracking may occur. In certain types of maintenance work this may not be objectionable, but of a first class job is desired on high carbon or alloy steel new flux should be used.

Coke oven gas is available at the welding lathe for use on jobs that require preheat, also compressed air for cooling the work when this is necessary.

Some consideration of the basic characteristics of this type of welding will help one to appreciate the possibilities of the process and why it has opened entirely new fields for welding in maintenance work.

The first and probably most striking advantage is the extremely high deposition rates that are possible while producing welds of 100 per cent X-ray quality with very low spatter loss. On round pieces the rate is limited only by the diameter or mass of the work. It is obvious that only a limited pool of molten metal can be retained on top of a rotating shaft, however, in most cases the welding rate is limited by the capacity of the piece to dissipate the welding heat since the slag will not come off when the temperature of the work goes

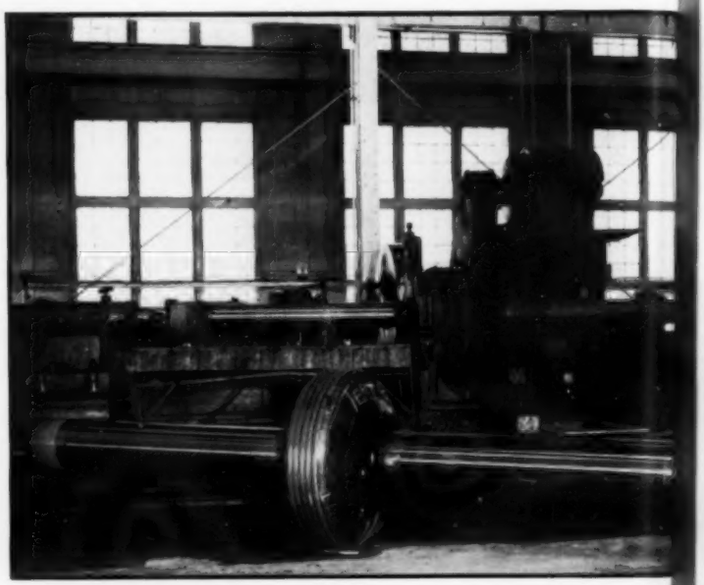


Figure 3 — These gas engine piston rods and pistons were reclaimed by submerged arc welding.

much above 800 F. On a 16 in. diameter shaft a welding rate of about 30 pounds an hour is attainable, while on an 8 in. diameter shaft a rate of about 10 pounds an hour can be expected. On very large work there is no reason why 40 to 50 pounds of metal an hour could not be deposited with a single head. When metal can be deposited at this rate, a job requiring 2,000 pounds of deposited metal can be completed in 8 or 9 eight hour turns or about 3 days if the shop works 3 turns a day. There is at least one case where a midwestern mill using one welding head deposited 13,000 pounds of metal on a back-up roll in 18 days. It may be stated that for practical purposes the amount of deposited metal required is never the limiting factor when using the submerged arc process.

The second advantage is the very high rate of heat input to the work which in most cases makes it possible to maintain the work of 600 to 800 F during welding. Preheat temperatures in this range are sufficiently high to eliminate all hardening of the fusion zone in mild steel and in most of the medium-carbon and low-alloy grades. When the welding is done at these temperatures and held at or near the same point for a number of minutes,

after deposition, considerable drawing and stress relief takes place and in most cases no treatment after welding is necessary.

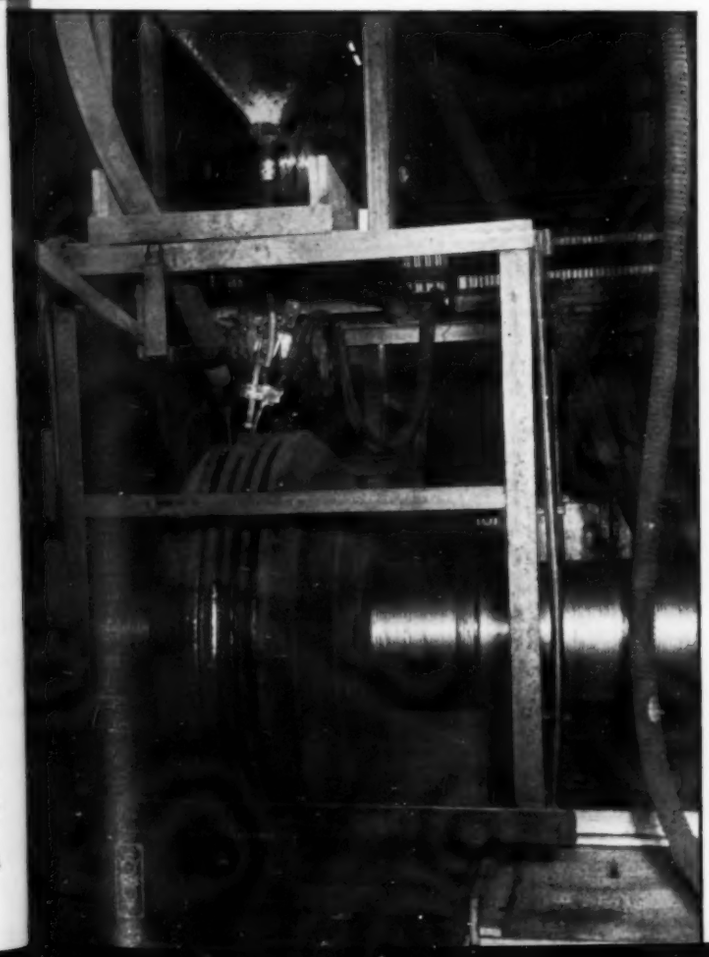
With both sufficient experience and data there is reason to believe almost any desired thermal cycle could be obtained by the proper combination of preheat, electrode size, welding current, speed of rotation of work and carriage feed per revolution of the work.

The third point is the wide variety of electrodes that are available for application by the submerged arc. The following list will give some idea of the materials that are available:

1. Low cardon rod with high ductility for welding heavy fillets in one pass, corners and joints of simlar high stress characteristics.
2. 0.60 to 0.75 per cent carbon rod for building up wearing surfaces. This is a low price rod and probably one of the most useful one for steel mill maintenance.
3. Standard S.A.E. alloys—4330, 4340 and 6150.
4. Stainless alloys—types 304, 308, 309, 310, 317, 347, 430, 446, 502, 420 and 440.
5. Everdur, nickel and monel.
6. 13 per cent manganese, 3½ per cent nickel.
7. Fabricated alloy wire in several analyses for hard surfacing applications with hardnesses ranging from Rockwell C32 to C55.

In view of the fact that most if not all of the above materials can be applied free from cracks and porosity by using the proper procedure, the possible application of the process is almost unlimited.

Figure 4 — The ring grooves in this gas engine piston were rebuilt by welding but in order to save machining and weld material, the grooves were not filled in solid.



A more or less detailed description of some of the more important work being done by this process will give some idea of the wide field of application and possibilities of this type of welding.

GAS ENGINE PISTON RODS

The reconditioning of gas engine piston rods is our most important application of the submerged arc welding process. These rods are 15 in. in diameter and 17 ft 7 in. long with a 47 in. diameter piston, the center line of which is 8 ft 6⅜ in. from one end. Each end of the rod for a distance of about 10 in. has a special thread 2¾ per inch, 14¾ in. diameter measured over the top of the threads. A finished rod, reconditioned by submerged arc welding, is shown in the foreground of Figure 3, while in the lathe a smaller piston rod is being finished.

It has been the practice at the Steelton plant to run a new rod until it became worn and then turn it down to a 14¾ in. diameter and use an odd size packing. When the 14¾ in. diameter became worn, the rod was turned to 14$^{9}/_{16}$ in., prepared for metal spraying, and then metal sprayed to finish at 14¾ in. The metal sprayed rods gave about twice the service of a new rod. The first cost of metal spraying was rather high but the cost per hour of service secured was much less than rods welded on the automatic welder using bare electrode.

Since starting to use the submerged arc for reconditioning piston rods, the new 15 in. diameter rods are no longer being turned to 14¾ in. diameter when they become worn but are sent to the welding lathe and a single layer of weld metal applied and refinished to 15 in. diameter. The rods that have been turned to 14¾ in. are sent to the shop when they become worn and two layers of weld metal applied and then finished at 15 in. diameter. If the rod has been metal sprayed at 14¾ in. the sprayed metal is removed and three layers of weld metal applied so the rod will finish at 15 in.

Thus far a total of 7 rods have been built up from 14¾ to 15 in., using a total of 6,690 pounds of electrode or an average of 960 pounds per rod. The 3 worn 15 in. rods that have been welded with one layer and then refinished to 15 in. required an average of 377 pounds of electrode per rod.

The welding of piston rods is now a one-man operation and the overall average welding rate using $^{3}/_{16}$ in. diameter, 70,000 pounds tensile electrode is 19 pounds per man-hour. Thus the average time required to weld a 14¾ in. rod to finish at 15 in. is 50 man-hours and to recondition a worn 15 in. rod is 20 man-hours.

We are still using 70,000 pounds tensile electrode as the standard type for rebuilding piston rods, although several rods have been built up using 0.60 C, 1.00 Mn electrode. In order to get a perfect weld free of cracks, the welding rate of the latter grade is just about half that of the 70,000 pound mild-steel electrode. No service records are available as yet so no conclusions can be made as to which is the better electrode to use.

The threads on the ends of the rod are subjected to very high stresses and are often damaged to such an extent that they must be replaced. A number of different methods have been used to renew the threads, all of which left much to be desired.

The following procedure has been used to renew the

threads on several rods, and so far as can be determined, seems to be far better than any other method used thus far.

1. The damaged threads are removed to a depth of ⅛ in. below the root of the thread.
2. Area is magnafluxed for any possible cracks.
3. Rod is preheated to 600 F.
4. Necessary amount of metal is built up, using S.A.E. 6150 alloy electrode.

The weld has a uniform hardness that is sufficiently high to allow the cutting of threads with a finish equal to or better than the original ones. The average time and material required to build up the threads on one end of a rod is 15 man-hours of labor and 145 pounds of electrode.

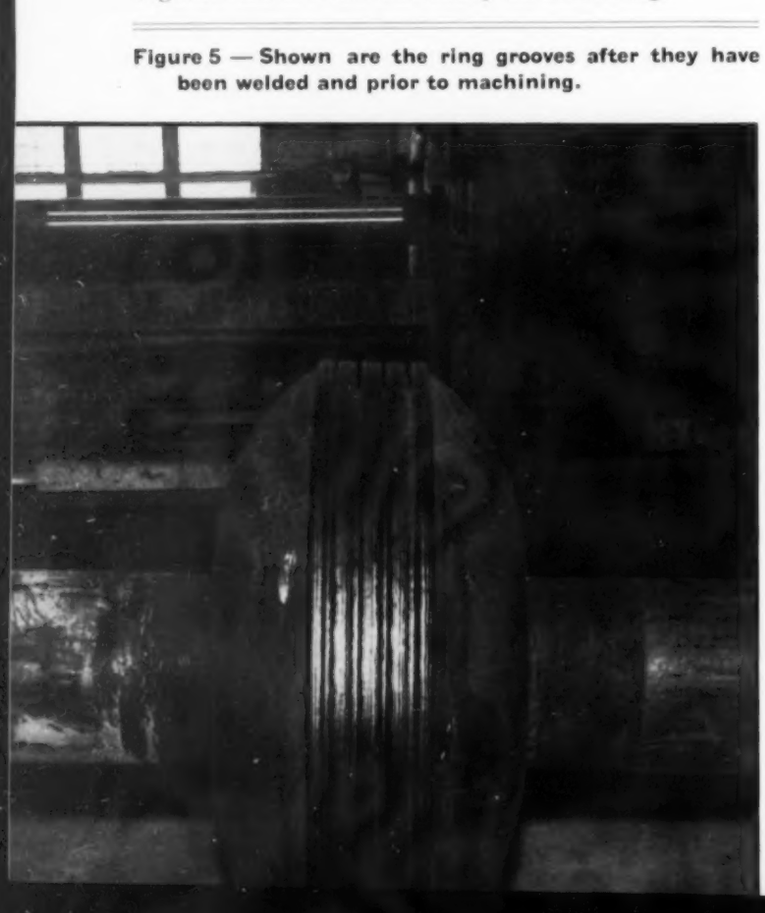
Along with the building up of worn piston rods the welding of worn ring grooves in the pistons for the gas engines is one of the most important applications of submerged arc welding in our plant.

It is interesting to follow the different procedures used on this particular job as experience was gained.

The pistons have 4 ring grooves each ⅞ in. wide and 2 in. deep. The first pistons were repaired by cutting out all of the old "bare wire" weld and then filling the grooves in solid with weld metal. This made a satisfactory job but it required a large amount of weld metal most of which had to be removed.

The next stop was to prepare the piston the same as before but instead of filling the grooves in solid, the bottom of the groove was filled in to the requred height and then a single layer of weld metal put up each side of the groove and the required amount of the lands between the grooves. This resulted in a considerable reduction in the amount of electrodes required and since a ¼ to ⅜ in. opening was left in the groove the machining was much easier than when the grooves were filled in solid. Figure 4 shows a piston in the welding machine and Figure 5 the finished weld ready for machining.

Figure 5 — Shown are the ring grooves after they have been welded and prior to machining.



Up to this time all welding had been done with 70,000 psi tensile electrode. In order to get better wearing properties in the ring grooves we tried welding a piston with a 0.60 C, 1.00 Mn electrode.

Since these pistons are half full of water and it is not practical to remove the water, no preheat is possible. Under such conditions we were unable to eliminate longitudinal cracks in the beads at the bottom of the grooves, however, after starting up the sides no more cracking occurred.

The major part of the wear in the ring grooves occurs in the upper half of the grooves; therefore, the next piston was welded using the following procedure: The bottom of the groove and two or three turns up each side of the groove was welded with mild-steel electrode and then the remaining portions of the sides of the grooves and top of the lands were welded with 0.60 C, 1.00 Mn electrode which now represents the standard procedure for welding piston ring grooves. To date a total of 16 pistons have been welded with the submerged arc process involving a one-man operation, requiring an average of 38 hours of labor, including set-up time and 375 pounds of electrodes.

No service records on these pistons are available as yet, but there is every reason to believe they will give service equal to or better than new ones.

WELDING OF WORN EXHAUST VALVE STEMS

This job is another very successful application of this type of welding to gas engine repairs.

The overall length of the valve is 46⅛ in. with a 14½ in. diameter head and the main part of the stem 4⅝ in. outside diameter with a 2 in. bore. The portion of the stem that operates in the bushing and needs rebuilding from time to time is approximately 18½ in. long and 4⅝ in. in diameter.

The first attempt to rebuild these stems with the submerged arc was not too successful due to excessive heating of the stem. After trying several different methods of cooling the stem, the following one was developed and has proven very satisfactory.

The 2 in. diameter bronze plug in the base of the valve is replaced with a special plug. Into one end of this plug a piece of ¾ in. standard pipe capped on one end and having 34 ⅛ in. holes located in such a way as to distribute cooling air uniformly over the inner surface of the area to be welded. The cooling air is introduced through the special plug by means of a hollow center in the tailstock of the welding lathe.

The average time required to build up a valve stem by hand was 18 man-hours. With the automatic welding the average time is 4 man-hours per stem. Along with reducing the labor required to 22 per cent of that necessary to weld a stem by hand, the automatic process makes it possible to apply wear and heat-resistant type of alloys to the stem. A number of different types of alloys are being tried but no service records are available as yet, however, there is little doubt but what the service life of the valve stems can be greatly improved. Three exhaust valve stems welded by this method are shown in Figure 6.

Figure 6 — Exhaust valve stems were welded by the submerged arc method and thus reclaimed for further use.

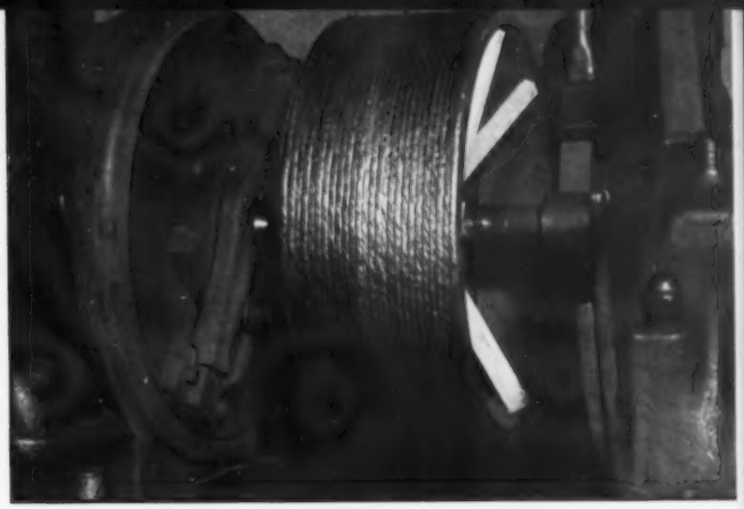


Figure 7 — Hard facing is applied to brake wheels by the submerged arc process. The wheel shown is set up ready for grinding.

HARD SURFACING OF BRAKE WHEELS

Several years ago when the inexpensive type of hard surfacing electrodes providing deposits with Brinell hardnesses ranging from 250 to 600 were introduced, we started experimenting with fabricated brake wheels hardfaced by manual welding. These brake wheels were very successful from the standpoint of service but were rather expensive due to the amount of labor required to hardface them by manual welding and the time required to grind the relatively rough surface produced by hand welding.

The application of hard surfacing material by the submerged arc process resulted in such reductions in welding and grinding time that we are now able to fabricate brake wheels much cheaper than we can buy them; and are receiving much better service than we ever obtained from the best brake wheels we could purchase.

Another big advantage is that any size or shape of brake wheel that may be required can be made on a few days notice so the inventory of wheels that must be carried can be greatly reduced. A fabricated wheel hardfaced by the submerged arc process in the grinding machine ready for finishing is shown in Figure 7.

16 IN. SEMI-STEEL MERCHANT MILL ROLL

The necessity of rolling a new section usually requires a new set of rolls. However, in one instance, our inventory furnished a set of rolls that would be suitable for this section provided one pass on the middle roll could be built up to the required diameter. Since the roll was of no value as it was and a new roll would have to be cut down to fit the other two, it was decided to try building up the pass by submerged arc welding using 0.60 C, 1.00 Mn electrode. An analysis of chips taken from the roll showed the following:

C	Mn	Ni	Cr
1.726	0.50	0.90	0.77

This analysis was anything but encouraging, however, plans were completed and the following procedure was used:

1. Preheat to 700 F with gas torch.
2. Weld with $\frac{3}{16}$ in. electrode using straight polarity, 500 amp, 30 volts.
3. Surface speed of work, 12 in. per minute.
4. No post heat treatment of any kind.

The welding required 100 pounds of electrode, 130 pounds of flux and 24 man-hours of labor and resulted in a direct saving of about $700.00.

The first layer of weld was very rough and contained many gas holes and some transverse cracks in the beads. However, the second layer, applied directly on top of the first without removing any of the gas holes or cracks, corrected this condition and the rest of the way was smooth going.

Even though no post heat treatment was given the roll, no trouble was experienced while finishing the weld to the required section. The fusion line was somewhat harder than the rest of the roll but was well within the machineable range.

The cost of stress relief or other post heat treatment is quite an item and if it can be dispensed with, a considerable saving can be realized. To date we have welded the working passes on 3 rolls, the necks and thrust collars on 3 other rolls, using the same procedure as outlined and without any post heat treatment. So far the results have been satisfactory in every respect.

The extent to which this welding process can be applied to roll welding is still to be determined, and considerable work must be done to develop the proper procedures and electrodes to use. The possible savings that could be made by the satisfactory repair of roll necks and working passes certainly justify further work on this phase of the process.

RECONDITIONING OF WORN CAST-IRON 20 IN. INTERMEDIATE DRAW BLOCKS

The most unorthodox applicatoin of the submerged arc welding process that we have made to date was the building up of worn cast iron draw blocks for the wire mill. These blocks are 20 in. in diameter and are used to pull the wire through the dies. The wire eventually cuts a groove in the block and when the groove reaches a certain depth, the block is reconditioned by turning it undersize. This operation can be repeated several times before the block must either be built up or discarded.

A number of these blocks have been reconditioned by

metal spraying with very satisfactory results but the cost is rather high. There are a considerable number of these blocks in use and the possibility of building them up with the submerged arc was so attractive it was decided to risk a block experimenting with it.

Since the block is a fairly complicated casting having a number of internal cooling fins and braces between the hub and rim, the method of preheating was given very careful consideration. Gas preheating torches were used and the heating done in such a way that the rim of the block was 600 F and the hub between 700 and 800 F. This distribution of heat was carefully maintained during the entire welding operation.

The actual welding procedure was as follows:

1. The area to be welded was undercut to 19¾ in. diameter.
2. The first layer of weld metal was deposited in the following manner:
   ⅛ in. diameter soft steel electrode, 26-28 volts, 260-280 amp.
   Surface speed of work, 15 in. per minute.
   Carriage feed, ¼ in. per revolution of work.

This produced a layer of weld metal $\frac{3}{32}$ in. thick having a number of pin holes and a few checks but securely bonded to the cast iron.

The second layer of weld was put on exactly the same as the first except that ⅛ in.—type 420 stainless electrode was used instead of soft steel. This layer was perfect, being entirely free of pin holes and checks, and the third layer was applied exactly the same as the second.

Several blocks have been reconditioned by this method and while no service records are available as yet, they are in perfect condition after several months of service.

These are only a few of the applications that have been made at Steelton where to date all of the work has been done in a lathe. When the possibilities of mounting a welding head on the arm of a shape cutting machine for welding on flat surfaces, welding of work on manipulator face plates and the use of the new semi-automatic submerged arc equipment for hand welding are considered, the possibilities of this type of welding are almost unlimited.

DISCUSSION

PRESENTED BY

L. P. ELLY, Welding Supervisor, Bethlehem Steel Company, Bethlehem, Pennsylvania

L. P. Elly: In addition to the advantages of this welding process as mentioned in the excellent paper, we might consider two additional minor advantages, namely saving in amount of deposited weld metal required on any one job, and possible economy in hard-surfacing application.

Through the proper control of arc voltage, current and speed of travel, the finished surface of weld metal deposited by the submerged arc process is extremely regular, as clearly shown in several of the illustrations. Therefore, the amount of weld metal necessary to assure cleaning up after welding to finished diameter is considerably less with this process than with other automatic welding processes. In the reclamation of gas-engine piston rods using the submerged-arc process we weld to $\frac{5}{32}$ in. over finished diameter size to assure "cleaning up" during machining after welding. With the automatic bare-wire welding process it was necessary to weld $\frac{5}{16}$ in. over finished diameter to assure "cleaning up" during machining after welding. A substantial savings in reclamation costs can thus be realized with the use of the submerged-arc process.

The combination of high electrode cost and manual-welding labor cost has rendered many possible hard-surfacing applications in the steel mill uneconomical. However, the great reduction in labor cost depositing hard-surfacing materials with the submerged-arc process renders many such applications feasible. In addition, the relatively smooth finished contour of the hard-surfacing material greatly reduces expensive grinding and machining costs after welding.

We have found that in welding with this process where relatively high preheat is required, slag removal becomes a difficult problem. A pneumatic sand bench rammer equipped with a spud and mounted on the lathe carriage, traveling with the head, does an excellent job of automatically removing the slag.

In closing this discussion the writer wishes to mention a few illustrations showing the wide field of application and possibilities of this type of welding.

One case is that of a journal repair on a 0.60 per cent carbon cast-steel bloomer mill roll. Before the roll had seen more than a fraction of its expected service a broken journal box deeply scored the two journals. The roll was preheated to 400 F and built up with a 0.60 per cent C, 1.0 per cent Mn electrode. After welding the entire roll was annealed at 1450 F, machined, and placed back in service. It is too early to completely evaluate this job, but an expenditure of $455.00 reclaimed a $4,500.00 roll which would have been scrapped because of the deep scores on the journals. The welded roll is still going strong at this writing after rolling 50,000 tons. The life of a new roll is about 200,000 tons; with submerged-arc welding followed by a full anneal, we expect the welded roll to be comparable to a new one.

In another case journals of a hardened steel roll required weld metal to restore them to their original diameter. The entire roll was preheated to 400 F before welding, using a gas burner. The journals were welded with a mild-steel electrode at approximately 425 amperes, 25 volts, a surface speed of 25 in. per minute, and $\frac{3}{16}$ in. feed per revolution.

A mill-table roller was also rebuilt to original diameter with the submerged-arc process. The roll body and both journals were rebuilt and machined to original diameter with a 0.60 per cent C, 1.0 per cent Mn weld metal.

Journals on a mill-drive spindle were worn to 18½ in. in diameter and rebuilt to 20¼ in. diameter, with submerged arc requiring approximately 240 lb of 0.60 per cent C, 1.0 per cent Mn weld metal per journal. The total arc time required for this build-up was 32 arc-hours, resulting in an average deposition of 15 lb per arc-hour.

Principles of Job Scheduling IN A MACHINE SHOP

By L. E. FULLER, JR., Assistant General Foreman, Machine Shop
Carnegie-Illinois Steel Corporation
South Works
Chicago, Illinois

. . . . the basic considerations which must be met in establishing an orderly and efficient procedure for scheduling work in a machine shop are outlined in this paper . . . .

▲ THIS discussion of the principles of job scheduling in a machine shop is not an attempt to propound any new or revolutionary scheduling techniques, nor is it intended to present a formula or system that can be accepted as the solution of any particular scheduling problems. Primarily, this discussion is directed to the management of jobbing machine shops where a controlled schedule has not been developed; where the planning, expediting and completion of work is accomplished by the unusually retentive memory of the supervisors—supervisors who maintain a steady output of work solely by their own individual and collective efforts. This is a discussion that briefly presents the fundamental factors of a scheduling to be recognized, understood, accepted, controlled, and correlated into a program that can be used as a general guide for the development of a specific scheduling application.

Before exploiting the field of machine shop scheduling, it is important to have attention directed to a very simply stated, but difficult attitude to grasp. This attitude is the one prevalent in many shops relative to the amount of and complications of paper work. It is useless to argue that paper work is unnecessary in a scheduling system, as it is useless to disagree that the quality and quantity of paper work experience has created this attitude itself. It is not intended to advocate a blind plunge into the scheduling problem by accepting any proposal that is advanced. Each step in the process must be analyzed as completely as any of the most difficult shop problems, but constantly direct efforts toward the attainment of a scheduled control of orders. When this is attained, then concentrate on the necessary refinements to make a program economical and simple by revising, modifying and eliminating costly paper work.

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 25, 1947

CERTAIN ASSUMPTIONS MUST BE MADE

It is necessary for sake of clarity and brevity, to accept certain assumptions in order to confine the subject to a scope concerned primarily with a machine shop. By virtue of these assumptions, the first step can be made directly into the shop without digressing too far afield on those functions that should be, but do not have to be, performed outside the shop proper.

Therefore, it is assumed for purposes of this discussion, that a central order handling agency has been developed and installed to perform the following prescheduling functions. By a central order-handling agency is meant an organized group of personnel trained to correlate the various order activities that are common to two or more dissimilar repair shops. The prescheduling functions, which have been assumed, are as follows:

1. Determination of material requirements.
2. Procurement of, and availability, of material.
3. Development of requests for repair and maintenance work to determine:
   a. Method of operation.
   b. Quality and quantity of order requirements.
   c. Sequence of operations.
   d. Operational time allowances.
4. Preparation of forms to adequately provide the transmission of order information.
5. Development of a preferential order system to establish a sequence of order processing.

A complete discussion of the above pre-scheduling functions, as well as those required to develop the scheduling of orders within the shop, requires too much time and too many details for one presentation. However, as these pre-scheduling functions are very definitely related to the requirements of shop scheduling, they will be briefly explained.

DETERMINATION OF MATERIAL REQUIREMENTS

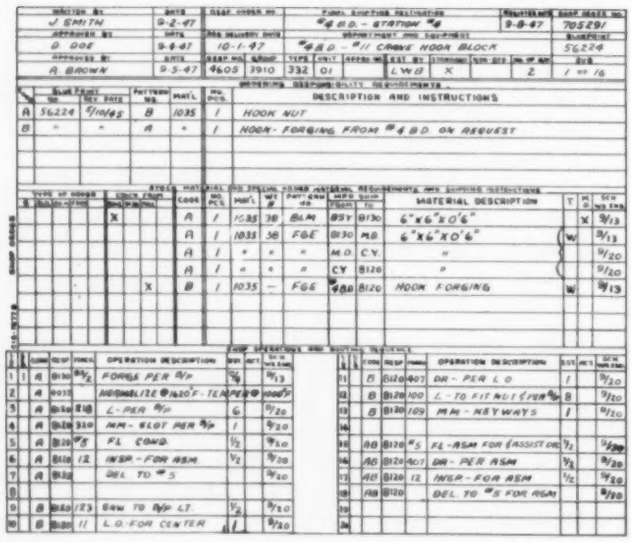
It is conceivable, and sometimes practical, to have each shop determine the material requirements for its respective part of the order, but the correlation and detail required in large shops is burdensome and costly, and is best established in a central control. This can be readily seen in the simple example of the complete bill-of-material for a 20-ton hook block. Normally, the material requirements for the first shops involved are as follows:

Sheave guards —Foundry (outside purchase) or welding shop fabrication.
Sheaves —Outside purchase or welding shop fabrication.
Sheave pin —Machine shop.
Hook beam —Blacksmith shop.
Side plates —Welding shop.
Key plates —Boiler shop.
Thrust washers —Machine shop.
Bolts —Stores stock.
Alemite fittings—Store stock.
Roller bearings —Outside purchase.

Before work can be started on such a job, by any or all shops, the blueprints required to make the hook block must be analyzed for all material requirements, both for specification and quantity. Substitutions of material specifications must be made depending on availability and supplier delivery dates. Adequate orders must be prepared for material that cannot be obtained from stock, and orders must be prepared for the accumulation of stock material.

Obviously, whether material requirements are determined by a central agency or by each shop, such material must be procured and stored for immediate use when requested by the shop schedule. The procurement of material involving the placement of orders, follow-up contacts and files, receipt of material, records, etc., should logically and naturally be established in a responsibility trained in the required operations. The storage of material can be handled in a broader manner by retaining it in a central location for all shops up to a predetermined time in advance of the shop schedule, and then transporting it either to a specific shop yard or into the shop itself where availability is a matter of seconds. This procedure is strongly recommended for large volume shops where material storage and availability are factors that can easily upset established schedules.

Figure 1 — This form is used in the shop for work performance and is duplicated in the office copy of the shop order. The top of the form contains general shop order information and is the same on all shop order paper. The top third of the shop order contains a description of the parts to be made on this job. The middle third contains the record of material requirements and material transfers needed to handle the items on this job. The lower third of the shop order contains the operations required to perform the work requested. The maintenance material order and the maintenance material transfer are obtained from the middle third of the form, and the intra-shop transfer and operational schedule card is obtained from the lower third.



DEVELOPMENT OF REQUESTS FOR REPAIR AND MAINTENANCE WORK

Even to the inexperienced laymen, it is evident that shop work cannot be started until material is available to be processed. It is just as obvious that when material is available, there must be a plan to follow for processing the material; there must be directions and instructions that are the result of careful analysis and not the result of on-the-spot snap decisions. These directions—this plan—is the shop order.

The shop order must be the culmination of analytical study by shop experienced personnel to determine, first, the most economical, efficient and usually the most expedient way to fulfill the order. This is the determination of "how the work should be done." Second, the quality and quantity of the order requirements must be established to provide a good product in an economical amount. This is the determination of "what should be done." Third, "where the work is to be performed" within each shop is transmitted to the shop through a sequence of machining operations that encompass all work necessary to produce the product requested. Fourth, each operation in sequence must be considered in relationship to every other operation, on the basis of time requirement. The estimated time, either from experience or records, must be established for each operation to enable the mantenance of machine loads. This develops "when the operation or order should be completed."

Each of these four factors "how the work should be done, what work should be done and when the work should be done," provides the shop with the tools for both operation and schedule.

The conclusion that the order form is very important in the matter of schedules is, I believe, apparent from the previous discussion. And with this conclusion, again comes the evident fact that paper work is vital to a schedule system as a means of conveying a vast amount of order information.

Basically the order forms required for the transmittal of information and establishment and maintenance of schedules are, briefly, as follows:

1. *Shop order envelope or pouch*—A semi-permanent

presentation of the shop order to be used in the shop proper. An envelope or pouch is recommended as a convenient means of transmitting the necessary order forms to the shop and as a holder for the required blueprints as the order progresses through the shop. The order information can be hectographed on the face of the envelope to complete the compactness of the form.

2. *Shop copy of the shop order*—This form contains all pertinent order information required to process a piece of equipment or material in the shop. It is hectographed on a printed form and is used to convey order information from operation to operation within the shop.
3. *Office copy of the shop order*—This form is identical to the shop copy of the order and may be prepared on a printed form or on blank white paper. It is used solely as a progress sheet in the shop schedule office and as a register of orders received and in process in the shop. Figure 1 illustrates both the shop copy and the office copy of the shop order.
4. *Maintenance material order*—This form is for the requisitioning of stock material either from the stores department or the maintenance planning department. It has been developed so that it can be prepared in hectograph from the same master as is used for the shop copy of the shop order. All material ordered and all material required from stock as determined by the planners in the planning department can be contained on the maintenance material order and sent to the shop in advance of shop work.

   The miscellaneous items of stock such as cotter pins, washers, small bolts, etc., that cannot be determined accurately in the pre-planned order can be requisitioned by preparing the material order in the shop in pencil. The details of this form are shown in Figure 2.
5. *Maintenance material transfer*—Similar to the maintenance material order, this form can be prepared in hectograph in advance of order release to the shops, or it can be prepared in pencil for shipments of material that are exceptions to the planned order.

   A close scrutiny of the maintenance material order, the maintenance material transfer and the shop order itself will reveal the position and extent of identical information, thus enabling the planning department to prepare all required order paper from the hectograph master of the shop order.

   It may be well to point out at this time that the hectograph master and the shop order are identical forms with the exception that the master is printed on glazed paper.

   The maintenance material transfer is illustrated in Figure 3.
6. *Intra-shop transfer and operational schedule card*—This card can be considered, from the standpoint of shop scheduling, the most important of all shop order paper. It performs a four-fold purpose within the shop; first, it is a means of establishing a centralized master control schedule in the shop for all operations on the shop order; second, it provides each shop supervisor with a control schedule for all operations on the shop order within his section; third, it is a means of moving material within the shop from completion of an operation to the location of the next operation; and fourth, it provides the complete transmission of order information required to maintain accurate and up-to-date shop order progress within the schedule control point in the shop.

   This form, like all others mentioned, is to be prepared in advance of order release from the hectograph master by the planning department. It can also be prepared by the shop in pencil for additional operations not covered by the original shop order. Figure 4 illustrates this form.

Figure 2 — The material order is printed on yellow paper to distinguish it as paper dealing with material, and is obtained from the middle third of the shop order hectograph masters. It is prepared in advance of order release to the shops eliminating a great deal of clerical work that would otherwise have to be performed in the shop.

MAINTENANCE MATERIAL ORDER

KEEP HEADS NO.	FINAL SHIPPING DESTINATION								REQ'STED DATE	SHOP ORDER NO.
	#4 B.D. - STATION #4								9-8-47	705291
REQ DELIVERY DATE	DEPARTMENT AND EQUIPMENT									BLUEPRINT
10-1-47	#4 B.D. - #11 CRANE HOOK BLOCK									56224
REQ'N NO.	GROUP	TYPE	UNIT	APPRO. NO.	EST. QTY.	STANDARD	MAN STD	NO. OF REQ'NS		SUB
4605	3910	332	01		LWB	X		2		1 OF 16

TWO COPIES TO GO TO MATERIAL YARDS FOR "ISSUE STOCK". BOTH COPIES TO BE SIGNED BY: SHOP GENERAL FOREMAN (OR AUTHORIZED PERSON); CLERK (REC'G & SHIP) UPON RELEASE; SHOP MAN UPON RECEIPT. BOTH COPIES TO BE RETURNED TO MAT'L PROC. SECTION, MAINTENANCE PLANNING DEPARTMENT, STATION 25.

GENERAL FOREMAN — REQ'N NO.

MATERIAL RELEASED BY — DATE

MATERIAL RECEIVED BY — DATE

QUAN. ORDERED	COMM. NO.	CLASS NO.	QUAN. DELIVERED	UNIT PRICE	TOTAL PRICE

No. PCS	MAT'L	WT. EA.	PATT. NO.	SHAPE	SHIP TO	MATERIAL DESCRIPTION	T	M.O.	REQ. NO. END
1	1035	38	BLM	BSY	B130	6"X6"X0'6"		X	3/13

PREFERENTIAL ORDER SEQUENCE

The preferential order sequence is the least complicated means of obtaining an answer to the most frequently asked question in any repair and maintenance shop. "Which order is to be worked on first?"

It is logical to assume that the responsible head of the department ordering the repair work is in a far better position to determine the relative importance of his order requests than anyone in the shop.

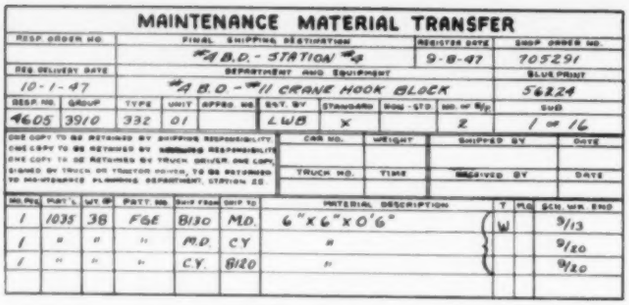
The development, transmission, collection and distribution of this information is the principle of preferential orders.

Each department in the mill, requiring service from the shop, prepares and maintains a preference list of its order requests in a numeral sequence. As orders are completed they are crossed out and as new orders are added they are assigned a number indicating the importance of each order in relationship to orders presently on the list.

More favorable results will be obtained at the outset of the program to have the preferential order list reviewed and revised by the ordering responsibility each week.

The value of the sequence will naturally be lost if the ordering unit does not keep its list active, and does not forward the list to the planning department prior to the period it is to be effective.

The maintenance planning department, or some other designated control center, must assimulate the preference lists from each unit, and in turn publish a



MAINTENANCE MATERIAL TRANSFER

RESP. ORDER NO.	FINAL SHIPPING DESTINATION				REGISTER DATE	SHOP ORDER NO.
	#4 B.O. - STATION #4				9-8-47	705291
REQ. DELIVERY DATE	DEPARTMENT AND EQUIPMENT					BLUEPRINT
10-1-47	#4 B.O. - #11 CRANE HOOK BLOCK					56224
DEPT. NO.	GROUP	TYPE	UNIT	APPRO. NO.	SPEC. BY	STANDARD	NON-STD.	NO. OF PCS.	SUB
4605	3910	332	01		LWB	X		2	1 of 16

ONE COPY TO BE RETAINED BY SHIPPING RESPONSIBILITY
ONE COPY TO BE RETAINED BY [illegible] RESPONSIBILITY
ONE COPY TO BE RETURNED BY TRUCK DRIVER. ONE COPY SIGNED BY TRUCK OR TRACTOR DRIVER, TO BE RETURNED TO MAINTENANCE PLUMBING DEPARTMENT, STATION 23

CAR NO.	WEIGHT	SHIPPED BY	DATE
TRUCK NO.	TIME	RECEIVED BY	DATE

NO. PCS.	PART'S	WT. EA.	PATT. NO.	SHIP FROM	SHIP TO	MATERIAL DESCRIPTION	T	MO.	SCH. WK. END
1	1035	38	FGE	B130	M.D.	6"x6"x0'6"	W		9/13
1	"	"	"	M.D.	CY	"			9/20
1	"	"	"	CY.	B120	"			9/20

Figure 3 — The transfer is printed in two colors; white for inter-shop shipments, and green for final shipment to the ordering responsibility. The transfer, like other shop order paper, is prepared in advance by the central order-control agency, and is obtained from the shop order hectograph master.

list to each shop containing the orders for the shop in numerical sequence. In its simplest form, the preference list to each shop will contain a "number one" order for each ordering unit as well as a "number two," etc. This may not cause confusion in the shop depending upon the volume of orders handled and the number of departments requesting work from the shop. Obviously, the preference list, at best, can only be a guide for the use of the shop, and the fact that there are more than one "number one" orders should not create confusion if the "number one" orders are processed first, as much as possible. It is stated in this manner because, due to machine loadings and operational sequence of the orders, it may be more practical to start a "number two" or "number three" order before a "number one." This procedure is perfectly satisfactory if the "number one" orders that are delayed are advanced when the first opportunity is presented.

It may be, as mentioned before, that the volume of orders and the number of ordering departments are too large and too numerous, thereby, creating too many "number one" orders for the shop to handle. If this condition exists, the responsibility for compiling the lists from each department into one list, within a division of departments, must be placed upon the office in charge of the division. For example, five rolling mill departments, each with a general maintenance foreman, may comprise a rolling mill division with a superintendent of maintenance. The preference list from each rolling mill department will create five number one orders, but if each list is reviewed by the office of the superintendent of maintenance and combined into one list, then for the rolling mill division there is only one "number one" order.

If the shop is of moderate size, it will not be necessary to combine department lists into a division list. The frequency of order completion will far exceed the number one orders requested.

We would like to digress for a moment to answer a question that undoubtedly has arisen in your mind in connection with preference lists. With a condition of more work for the shop than the shop can handle, and each ordering department presenting lists of what they desire, is it necessary to allocate the man hours in the shop to each department in order that each department will receive its due share of completed work? In our opinion, such a procedure is not necessary for the following reasons: first, a survey of the distribution of shop orders at different periods will probably reveal that the product mix of the shop, i.e., the distribution of completed work, will not vary appreciably from one year to the next, excluding, of course, unusually large jobs such as overhauling a mill, etc. Second, the preference list will have a tendency to correct the condition as only those orders required will be scheduled rather than any order to load a machine as is often the case. Third, any system regardless of its purpose, will not replace the personal contact between the shop and ordering department, nor is it a reasonable substitute for the ability of shop management.

It is imperative to appreciate that the question of shop allocation is very debatable, and what has been offered is only an opinion. Whether allotment is required or not is dependent entirely on the circumstance and conditions of each scheduling application.

It is evident from the foregoing discussion that successful scheduling is dependent upon the assumptions made. It is not intended to imply that the shop itself cannot successfully develop and apply the factors assumed, but the job is much easier if they are handled by a control agency. In either case, they are imperative to successful scheduling operation.

PRINCIPLES OF SCHEDULING

The principles of scheduling whether applied to a machine shop or welding shop or to a group of shops are exact and specific. The manner in which these principles are applied may vary considerably from shop to shop. Certain principles may be emphasized and others may be minimized but in one manner or another each will be used.

There are some general principles or factors of scheduling that should be discussed before beginning on the scheduling application itself. These general principles are more to create the proper mental attitude of shop management toward scheduling rather than to assist in the scheduling program installation.

1. "Don't send a boy to do a man's work." Realize at the outset that scheduling is going to increase your shop overhead. Develop your program around personnel who are thoroughly experienced in shop operation, who are alert and quick to accept suggestions and new ideas. Some clerks are needed in the program but do not make the foolhardy mistake of placing clerks in the key positions. The savings from scheduling must be realized through planning and not through payroll deductons and cheap, inexperienced labor.
2. Accept the fact that paper work is essential for control and for scheduling, and do not combat suggestions that involve new forms. However, do not accept any suggestion because it may, at the moment, appear satisfactory. Analyze any proposed form very thoroughly and carefully to determine that it will suit the purpose and will require a minimum of clerical expense. Emphasis must be maintained on the type of paper work that reveals quality rather than quantity.
3. Insist upon a system that is easy to understand and economical to operate. Never allow any part of a scheduling program to be installed, either against the wishes of shop management or without

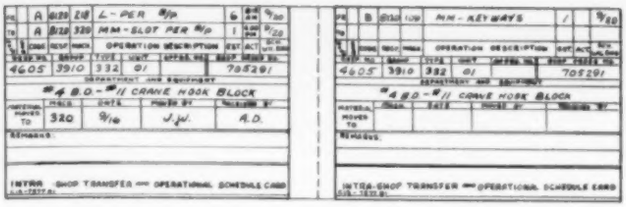


Figure 4 — This form is perforated on the dash line for hectographing from the shop order hectograph master. By the use of a blanking mask, each two lines on the lower third of the shop order is hectographed on the schedule card. The cards are separated for use on the shop schedule board.

their full and complete knowledge of every phase of its development and application. Every part of a scheduling system must be developed with shop supervision. The success or failure of the control will depend entirely on the shop supervisors, as they must make it work. It will not be successful by its own merits alone.

4. Demand, if you will, that your program be constantly policed, modified, and if necessary revised, by continued follow-up and instruction. As yet, no scheduling system has been devised that is without fault in its first application, or in continued application under certain conditions. It must be watched constantly to provide the accurate handling of exceptions, to provide faster and more accurate order handling and information, to provide the final system that produces the result intended and expected.
5. Bear in mind that order control encompassed five factors that must be controlled within varying degrees with each application.
   a. *The order*—The order requesting the work and order information required to successfully perform the work requested.
   b. *The material*—The material required to perform the work requested must logically be available before work can be started.
   c. *The labor*—The labor must be available and sufficiently flexible to handle the operations required to perform the work.
   d. *The time*—The time allowance to perform the work as well as the time limit when the work will be completed.
   e. *The sequence*—The sequence of preferential orders to designate the order of processing.
6. Finally, approach your scheduling with an open mind, realizing that no system can be expected to immediately, if ever, be the solution to every production problem. It is a guide, a plan, which if developed and used sensibly will produce results that are satisfactory. Mass production scheduling, after extensive and diligent applications can be expected to reach near perfection, but if your problem is job-shop scheduling do not expect to attain the same results. The unexpected occurs too frequently to maintain absolute control.

Specifically, order control within a machine shop, or for that matter, any repair and maintenance shop primarily concerned with job-shop operations, consists of three major principles: routing, scheduling and dispatching.

ROUTING

The principle of routing is often very indefinite and sometimes very ambiguous in its application, but I believe the factors of routing as outlined below will present the definition of the principle considered in this discussion. Normally, the routing factors are performed by a central order control agency, but they are enumerated here because of the close relationship to shop scheduling.

1. Analysis of the order request to establish the most efficient and economical method of processing the work required.
2. Analysis of the machine tools and facilities available in the shop to select those most desirable to perform the work.
3. Determination of the material available and required to perform the work.
4. Determination of the required operations and sequence of operations for each item.
   for each item.
5. Establishment of a time allowance for each operation either from experience or past records of performance.
6. Preparation of shop orders for the work required that present the information contained in the above five factors.
7. Preparation of auxiliary shop paper to the shop orders that will provide adequate control for the other principle of order control scheduling and dispatching.

SCHEDULING

The scheduling principle does not contain the multiplicity of factors as does the routing principle, but this in no way detracts from its importance. Actually, scheduling is the most formidable of the three principles because it is the easiest to prepare and the most laborious to maintain. This statement is made, with respect to the jobbing shop because of the unpredictable nature of the work. A schedule once established may stand uncorrected for a comparatively long period of time, or may require complete revision before the orginal is in any way activated. Constant and dissimilar changes in schedules can be and must be expected, and flexibility must be provided to manipulate the changes rapidly and accurately.

The salient factors of the schedulng principle are as follows:

1. Control of orders before assignment to schedule and before release to processing to facilitate finding any order at any time with the least amount of confusion and delay.
2. Assignment of each operation to machines or load centers to establish complete utilization of all facilities.
3. Assignment of each operation of the shop order to machines to maintain a continual and even flow of the material through the required processes.
4. Determination and assignment of due dates for the completion of each item and the coordination of subassembly completions, to final completion.
5. Assignment of operations and work according to preference as established by preferential order listings.

6. Flexibility of physical presentation of schedules to provide for unexpected interruptions to schedule and for the reschedule of rejected materials.

The control of orders prior to assignment to schedule and before release to processing may appear to be too inconsequential to dwell on at this time, but if not properly instituted, it can be extremely irritating. Too many shop supervisors have been severely criticized because of their failure or their organization's failure, to be able to produce any order requested. The system must establish one central file of office or progress copies of all orders received, and one file of all shop copies received but not released for processing. The simplest provision for control of orders will result in the most efficient handling of orders.

Factors 2, 3 and 4 above, those concerned with the assignment of operations and the determination of completion dates are the variables of the scheduling principles. They are considered variable as they require constant attendance, and present an entirely new problem with each order. Obviously, the most efficient operation of the facilities in a machine shop is accomplished by maintaining a full load on each load center to minimize the downtime on each machine. However, the full loading of facilities must not be maintained at the expense of efficient operation and order continuity. Stated in another way, do not load a machine merely because a man is scheduled to operate that machine, unless the work completed in the machine can be further scheduled on another machine in operational sequence, within a reasonably short time. Too often work is sent to a machine to keep it operating when it is known at the time that the completed work will be stored in a yard because other parts of the same order have not been placed in schedule. In such a case, from an economical standpoint, it is far better to schedule the machine as idle and place the operator on another machine that is truly loaded with desired orders. The decision to shut down a machine when the shop is overloaded with work is very difficult and is a decision that is not often enough made. Judgment, tempered with experience, and timing, tempered with a knowledge of the scheduled work, must be combined to justify such a move.

Striving for order continuty will also reduce the number of partially completed orders if the operations of the order are scheduled in sequence, or at the same time, to hold the delay time between operations or between items to the shortest possible time. It is quite impossible in a large shop to have orders constantly in motion from one operation to another, but that should be the aim. A good schedule presentation, and personnel who are able to visualize the successive steps of an order can come close to this attainment.

From the standpoint of shop operations, the schedule is the culmination of order planning and the elimination of guesswork. However, equal in importance is the ability of the shop, by means of the schedule, to determine in advance of completion, the date when each order will be completed. This is, of course, excluding the advent of unusual, unforeseen interruptions. It has often been stated, and correctly so, that repair shops are a service group to the operating departments and as such must maintain a customer service. This service does not necessitate completing orders on a date the customer requests, as this may be impossible, but it does require that the shop advise the ordering department approximately when each order will be completed, and then complete it at that time.

It is imperative, in order to provide this customer service, that each operation on an order is assigned a due date predicated on the time allowance for the operation, availability of machine facilities, and the relationship of each part of the order to one another. As each operation is placed in schedule, the completion dates or time consumed are accumulated until the completion date of the last operation determines the completion date of the entire order. This, of course, implies that accurate completion dates cannot be given until the order is scheduled.

A very minimum of machine shop experience will indicate the somewhat (from the shop standpoint) unreasonable, and certainly, numerous demands of the customer. How familiar is the answer, "I need it now," to the inquiry "How soon must you have this job?" It is certain knowledge that some orders must be completed before others, therefore, each order placed into schedule must be guided by the preferential order sequence mentioned previously in this discussion. Please note the use of "guided" not "dictated." Due to factors of material availability, machine availability and loading and the total time required to complete each order, it may be impossible to complete orders in preferential sequence but the processing should most certainly be guided by the sequence.

The last factor of the scheduling principle is, in our opinion, by far the most important, because without it the maintenance of schedules is impossible. This factor is the flexibility of the physical presentation of the schedule. Precisely, it means how easily and how rapidly the schedule can be revised to handle breakdown orders or other interruptions that require immediate and decisive action. Provisions must be made for such interruptions because they will occur, more or less frequently, and if not handled expeditiously, will soon throw the schedule behind machine operations. If this condition exists for long, there is no schedule.

The best results for loading a schedule will be obtained by having a form that represents a single operation and that can be handled physically as one operation. This physical representation can be attained by having a card, for each operation on the order, that contains sufficient pertinent order information to enable the card to stand alone without benefit of a copy of the complete order. Orders, and the schedule of orders, can be juggled, revised and rescheduled by the adept shuffling of operational cards without constant reference to the order and without the necessity of committing too much information to memory during the rescheduling operations.

The dispatching principle is composed of factors that are the policemen of the schedule, the controls by which material is made available and transported, the schedule is maintained, and order information is collected.

The factors of dispatching are as follows:

1. Control of material to accumulate the right material at the right place, at the right time, in advance of processing.

2. Movement of completed work from one operation to another as established by the routing on the shop order.
3. Maintenance of records of the time of start and completion of each operation for comparison with the time allowed.
4. Maintenance of complete order information.
5. Maintenance of records of rejected work and preparation of work orders to correct or replace it.
6. Reporting the occurrence of and reason for "behind schedule" work.
7. Control of shipment and records of shipment of completed work to next designation.

The control of material prior to the start of processing of any order can readily be understood to be extremely important when all other pre-processing work has been completed on the order. This control implies the collection of all materials required, whether they have been purchased from outside suppliers or obtained from stores department stock, or from storage yards, and physically transporting each item to the loading location as established by the order sequence. Timing is, of course, vital to this operation to eliminate delay at the start of operation caused by lack of material and also to eliminate excess storage within the shop because of premature movement. Possibly the most satisfactory results can be obtained by accumulating all material required to start an order in one location, frequently called an assembly bay, and then, by means of an appropriate form, have the supervisor or delegated person order the material into the shop at a definite date. This program has the benefit of confining the requests for material to those responsible for its processing and not to one or two individuals who must spread their activities to supply the material requirements of the shop. Also it places the responsibility for ordering the material upon the individual who knows best when he can handle it with least confusion.

Naturally, as with any phase of order control, simple and concise records must be kept of material movement to show date of movement, present location of material and the initials of the person who moved it. We would like to emphasize the practice of initialing the completion of responsibility throughout the many phases of order control. It is evidence of accepted and completed responsibility and automatically eliminates sloppy work because each move, each operation, can be checked back to an individual.

Subsequent movement of material, that is, the movement of material from one completed operation to the next operation in order of sequence is a continuation of the material control of dispatching. It includes receiving and recording the authorization of operation completion, the physical movement to the next operation, notification of the location of material to the next supervisor and receipt of his initial representing acceptance of the material. Again, simple and concise recording of material movement must be made on the office copy of the order to activate complete and up-to-date order progress.

There are two important conclusions to bear in mind on this factor. Material, when completed at one operation, must be quickly moved to the next operation. If material must await machining it should be stored at the location of this machining and not at the location of completed machining. Second, the location of material must be known and recorded so it can be found without an expensive delay from the standpoint of idle machines and idle manpower looking for the material.

The time allowances that are established for each operation on an order are normally developed by experience and records of past performances. Unfortunately the former must be used more often due to the time required to collect performance records. For this reason, there will be discrepancies between the time allowed and the actual time required for any operation. Regardless of the reasons for such differences, they must be recognized and if the effect is too great, schedules must be adjusted. Therefore, it is imperative that accurate records are maintained of the start and completion of operations to adjust schedules, if necessary, and to develop past performances that are sufficiently accurate to eliminate time allowances that are often incorrectly labeled, "questimates."

One cause of failure of many order control systems, regardless of their simplicity of complexity, is the lack of complete order information. The status of any order in process must be obtained from one source, that is not the physical check of the shop in an attempt to find the present status of any or all material on an order. This source of information should be the office file copy of the complete order, upon which is recorded all pertinent information to the extent that by reading the order, its past progress and present status can readily be plotted.

A record of rejected work for a weekly or monthly period, which is a function of dispatching, can be very revealing. It is one cause of "behind schedule" work and increased operating costs. This record need not be complicated but must definitely indicate the responsibility for work rejected in order that action can be initiated to eliminate it. In addition, steps must be taken to return such work to the source, and reschedule the job. Rescheduling the rejected work is a factor of scheduling, but the action required to place the work in a position to repeat certain operations is a function of dispatching.

Obviously, when promises are made for the completion of orders and these promises are not met, everyone concerned will want to know "why." It is the function of dispatching to report all "behind schedule" work and the reasons for failure, regardless of the responsibility, in order to eliminate repetition. No attempt should be made to "pass the buck" on schedule failures. No gain can be expected from concealment of the responsibility; it should be accepted as a valuable source of correction and handled as such.

The final factor of dispatching is the shipment of material after completion in the shop to the next department or to the customer. This, similar to other material movement, must be made accurately and rapidly, as completed orders are of no value to the customer until he receives them; and until they are shipped, the shop is cluttered with work that requires no processing.

Accurate records must be kept of all final shipments to clear all shop paper and to substantiate shipment if completion is questioned.

This discussion has, up to this point, dealt primarily in generalities relative to the principles of scheduling in

a machine shop. It is not implied by the term "generalities," that each salient point discussed should be taken lightly. However, they are word pictures that, at best, are hard to grasp and retain in this short period. For this reason an attempt will be made to clarify the disjointed factors into a composite outline illustrating the flow of paper and functions of personnel relative to the schedule application.

The composite of a scheduling scheme is shown in

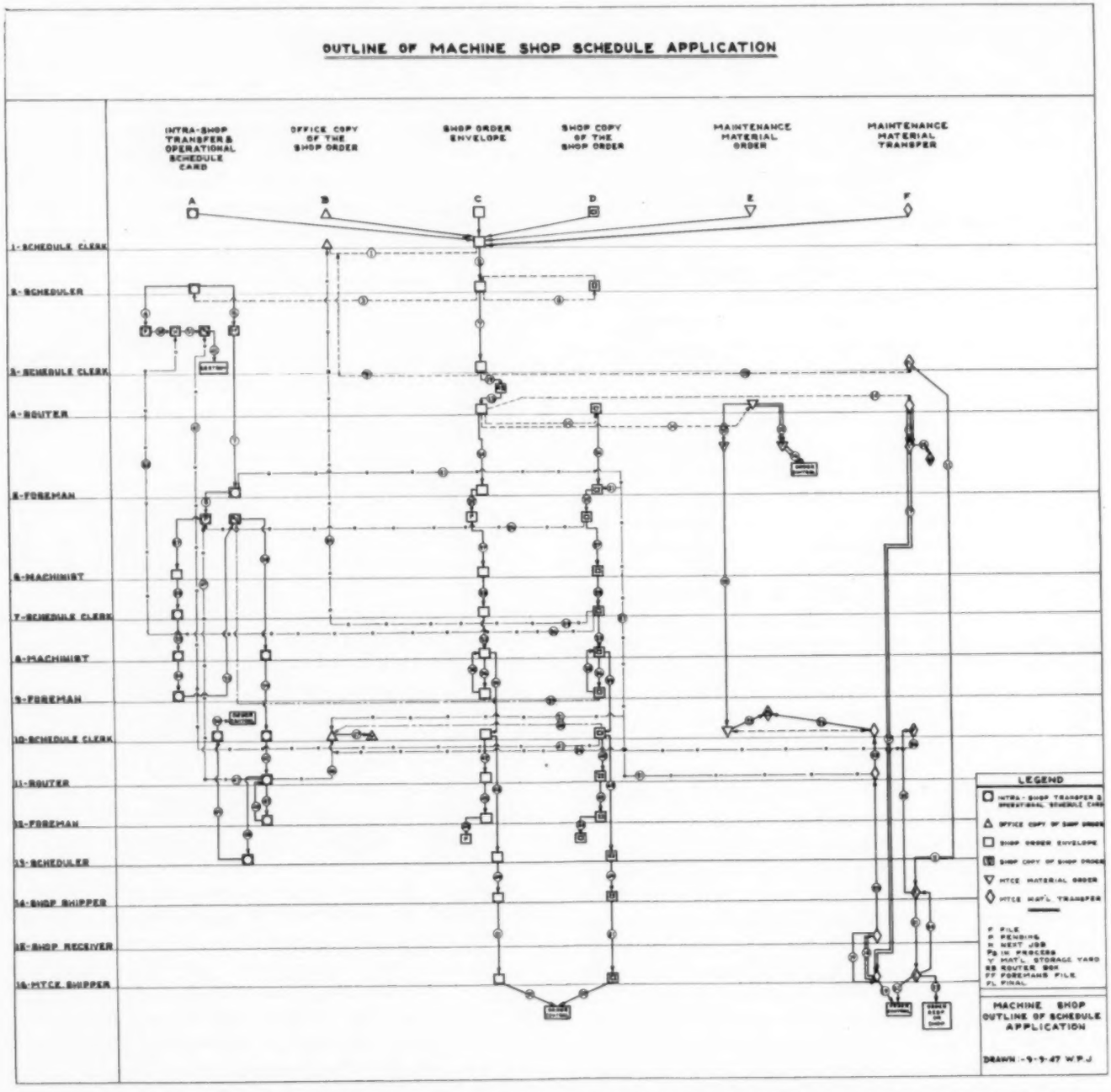


Figure 5 — A flow chart illustrating the steps and movements of shop order paper and shop personnel required to establish and maintain a controlled schedule orders in a machine shop.

Figure 5. An envelope has been introduced into the chart as a means of transmitting all other required shop paper and to facilitate the presentation. It is to be assumed in reading the flow of the chart, that all paper has been inserted in the envelope and is to be removed when needed as shown by dash lines. Actual progress of the paper through the various steps is portrayed by solid lines, and order information, distribution and recording is shown as dash and dot lines. All steps are numbered, as much as possible, in the sequence as they occur, and each form is represented by a symbol which is shown in the legend on the chart. The blueprints required to process the shop order are not shown in this figure. It is to be understood that the correct blueprints accompany the various subs of the shop order as they progress from operation to operation.

Chronologically, the movement of paper on the chart is as follows:

All shop order paper required for the schedule application is received in the machine shop by the schedule clerk from the central order control agency. The order information on each form is prepared in hectograph and is complete in each detail. The forms received include:

1. *Intra-shop transfer and operational schedule cards* —Two copies for each operation shown on the lower third of the shop order (Figure 4).
2. *Office Copy of the shop order*—One complete copy

of the shop order for each item or items listed in the upper third of each sub of the shop order (Figure 1).

3. *Shop order envelope*—One copy for each sub of the shop order.
4. *Shop copy of the shop order*—One complete copy identical to the office copy (Figure 1). The shop copy is used solely in the shop to furnish order information to shop foremen and workmen. It moves from operation to operation with the material.
5. *Maintenance material order*—Three copies for each item of material listed on the middle third of the shop order that is indicated as a material order in the column captioned "M.O." (Figure 2).
6. *Maintenance material transfer*—Three copies for each item of shipment listed in the middle third of the shop order that is indicated as a shipment in the column captioned "T" (Figure 3).

The schedule clerk reviews each order received and places them in preferential order as indicated by the preference list for the current period, i.e., all number one orders are placed together, all number two orders, etc.

The office copies from each order are removed (1) date stamped and filed in the progress file by shop order number. The remaining shop order paper contained in the shop order envelope is forwarded (2) to the scheduler. (3) The scheduler reviews the orders to be scheduled and, starting with the order that is to be scheduled first, as indicated by preference, removes the two copies of each schedule card. The cards should be received in sequence, first operation on top, etc., as indicated by line number on the shop order. The scheduler must now consider the following factors before placing each card in the schedule board:

1. The machine group or load center indicated on the card.
2. The type of work to be performed and the machine within the group best fitted for the work required.
3. The machine load on each machine within the group.
4. The number of turns per day and days per week operated by each machine within the group.
5. The best delivery that can be anticipated.

Arriving at a conclusion from these factors, he places one copy of the card in one of three pockets (4) depending on the load on the machine; the "In Process" pocket which must not hold more than one card for an operation already started or that can be started immediately; the "Next Job" pocket for the next operation to be started in the machine; or the "Pending" pocket which contains cards for all other operations to be performed on the machine in preferential order.

When the card is placed in the rack, the scheduler determines the week ending date upon which the operation should be completed, considering other operations scheduled and the time allowance on the cards. This date is inserted on both copies of the card in the space provided and on the shop copy of the order (8) together with the machine number scheduled. The duplicate copy of the schedule care (6) is placed in the respective department foreman's schedule box by machine number in the same sequence as placed in the schedule board. The foreman's copies of the schedule cards are delivered to the respective foreman (7) and are placed in a pending file (8) in the same sequence as received. Successive operational schedule cards for the order are handled in a similar manner, predicated upon the delivery date determined from the preceding schedule card.

The shop order envelopes, containing the remaining shop order paper are returned (7) to the schedule clerk who records the scheduled date and machine assigned for each operation on the office copy (9) and removes (10) the maintenance material transfers for the final shipment of each completed sub of the shop order. These final transfers are given to the shop shipper (11) who files them by shop order number until advised that the order is complete and ready for shipment.

The schedule clerk then places (12) the shop order envelopes of scheduled orders in the boxes assigned to the routers of each machine section corresponding to the shop foreman.

The routers remove the orders from the boxes (13) and separates the shop order paper for distribution (14) (shop copy of the orders, maintenance material orders and the remaining maintenance material transfers).

One copy of the maintenance material order is placed in file (15) after dating for material requirements and the remaining two copies, also dated, are sent to the material storage yard for material procurement. These copies, after fulfillment of material requirements, are sent (16) to order control.

The maintenance material transfers to cover the shipment of material from the storage yard to the shop are sent to the yard (15) with the material orders. One copy is kept in the yard file (16) for record purposes and the remaining two copies are forwarded to the maintenance shipper (17) to indicate that material is ready for shipment. When the material is shipped the transfers go to the shop receiver (18) who signs both copies, returns one to the maintenance shipper (19) and forwards the other (20) to the router. The router records (21) the date of receipt and location of material on the office copy of the order (10B) the shop copy of the order (5D) and the corresponding operational schedule card (5A). The material transfer is forwarded to the schedule clerk (22) who removes the file copy of the material order (4E) and places both in a completed file (10E). The file copy of the material order is used only as a means of follow-up to insure delivery of material in time to maintain continuity of schedule.

The router (4C and D), at the time of distribution of the material orders and transfers, also delivers (24) the shop order envelope and shop copy of the order to the respective department foreman. The foreman places this paper in file (25) pending start of work. The shop copy is checked (26) with the pending schedule card file (5A) to review schedule sequence of the order.

When the order is next in line to process, the foreman removes (27) the schedule card for the operation to be performed, the shop order envelope and shop copy of the order and gives them to the machinist who is to perform the work. The machinist carries the paper (28) to the schedule office of the shop and checks in the order with the schedule clerk.

The schedule clerk records the date of the operation on the office copy (29) records the start time on the schedule card presented by the machinist and checks

(30) the schedule card on the schedule board which should be in the "next job" pocket. This card the clerk moves (31) to the "in process" pocket to the "next job" pocket.

The schedule card, shop order envelope and shop copy of the order are returned (33) to the machinist. The machinist gives (34) the schedule card to the foreman who places (35) it in his "in process" file by machine number. The machinist then performs the work required by the shop order, and, upon completion, gives (36) the envelope and shop copy to the foreman. The foreman checks (37) the "in process" file, removes (38) the schedule card and gives it and the envelope and shop copy to the machinist to check in at the schedule office. Also at this time, the foreman gives the machinist his next job to do, and the sequence from (27) to (38) is repeated.

The machinist takes the order completed and his next job to the schedule clerk (39) who repeats the previous operation on the new job. The completed job finish time is recorded on the schedule card, the operation is marked (40) completed on the office copy and the completed schedule card is removed (41) from the "in process" pocket on the schedule board and destroyed.

The schedule card from the machinist, with the shop order envelope and the shop copy are given to the (42) router for the machine.

The router delivers (43) the shop order envelope and shop copy to the next department foreman who files (44) then in his pending file. The router obtains the material from the location of the last operation, moves it to the next operation, has the foreman initial (43) the card for receipt of material (45), records the new location of material on the office copy (46) and on the foreman's copy of the schedule card (47) in the foreman's "pending" file. The completed schedule card is then forwarded (48) to the scheduler who uses it to keep him advised of progress and to keep the schedule board up-to-date. The schedule card is then forwarded (49) to the schedule clerk who records whatever order information is required for statistical purposes. When all work is completed and recorded on the schedule card, it is forwarded (50) to order control.

The cycle of operations is repeated for each operation until the order is completed and the last operation is checked into the schedule work. On the last operation of the order when the shop order envelope, schedule card and shop copy are checked in (39) with the schedule clerk, the clerk forwards the shop paper to the scheduler to indicate completion of the order. This paper is then forwarded to the shop shipper who removes (51) the final maintenance material transfers for the job from his file and forwards them to the maintenance shipper together with the envelope and shop copy (51). The maintenance shipper signs the material transfers, sending one copy (51) to order control, one copy (53) to the ordering responsibility, and one copy (54) to the shop shipper. The other shop paper, after shipment of the completed orders, is sent (52) to order control.

The shop shipper records the shipment in his log book upon receipt of the signed material transfer and forwards (55) the transfer to the schedule clerk who places it in the completed file and removes (56) the office copy from the progress file.

CONCLUSION

An erroneous conclusion may be obtained from the foregoing discussion, that the principles of scheduling and the application of the principles are comparatively easy to understand and develop. Unfortunately, this is not true. This discussion has very briefly covered the more obvious phases of scheduling both in theory and application. It cannot be accepted as a detailed procedure of the work required to develop operating procedures for scheduling operations, to develop and train personnel to operate under the procedures and to combat the numerous interruptions that attempt to disturb the maintenance and continuity of scheduled machining operations.

It has been the intent of the presentation to convey one opinion of how scheduling can be performed and also to show to some extent, the various steps that shop order paper must take to establish a controlled order schedule.

DISCUSSION

PRESENTED BY

H. R. GRAVENSTRETER, Division Superintendent, Maintenance, Youngstown District, Carnegie-Illinois Steel Corporation, Youngstown, Ohio

E. I. STENTZ, Assistant to Superintendent of Maintenance, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

E. J. MOXLEY, Production Engineer, Wheeling Steel Corporation, Beech Bottom, West Virginia

L. E. FULLER, JR., Assistant General Foreman, Machine Shop, Carnegie-Illinois Steel Corporation, South Works, Chicago, Illinois

FRED C. SCHOEN, Plant Engineer, The Midvale Company, Philadelphia, Pennsylvania

H. R. Gravenstreter: We have had a relatively short experience with maintenance planning, our planning office having been in existence only 1½ years. We have preferred to start out on a simplified basis and to develop our planning group with the idea of obtaining profit from its operation. As we are all aware, the present higher shop rates make the profit possibilities today even more attractive.

In connection with the profit resulting from maintenance planning we find it is very difficult to obtain an actual measure of overall shop savings. Later investigation however, revealed that the jobs processed through our shops from time to time are essentially of the same character and that possibly a figure of shop manhours per job would be a good barometer of shop costs. A review of such jobs was made and it was found that manhours per shop job in our machine shop, at the start of maintenance planning, was 44. Today this figure is 33 manhours per job. This we believe is largely attributed to improved service of materials to and from the shops, improved planning and closer attention of the shop foremen to the actual machining operations. The picture is quite the same in our blacksmith shop, where a reduction in manhours per job was made from 29 to 20. This, we believe, represents real savings which will certainly

justify, in our opinion, the existance of maintenance planning.

Other points which I should like to discuss are backlog, promises, allocation of shop hours to customers, cushion for emergencies and responsibilities.

Backlog—We believe that it is essential that a backlog be maintained for all shops for the reason that shop forces can be better controlled to meet demand. In cases where the backlog becomes excessive and deliveries cannot be met because of manpower shortage, etc., work may be allocated by the maintenance planning office to outside contractors. In this way we are able to hold a relatively uniform shop force, handling the peak demands on the outside.

Promises—We feel that delivery promises must be kept. There is nothing, in our opinion, more damaging to shop planning than failure to meet promises. We are quite insistant that the delivery date requested by the customer is correct and have enjoyed considerable success in meeting our promises.

Allocation of shop hours to customers—We believe our experience in maintenance shops is quite the same as in other steel plants in that a large number of customers must be served. To assist us in this connection we have allocated shop hours in accordance with past experience to the various principal departments and the normal weekly schedule is based on this allocation. Further experience and reference to backlog may indicate an adjustment of this allocation from time to time and if so, such adjustment is made. In this way we are able to control the work done for the various customers very largely to their satisfaction.

Cushion for Emergencies—Our experience, no doubt in this connection, is no different than that in other plants in that emergency jobs are constantly occurring which must be taken care of even though they are not scheduled. We started out to schedule our shops on a 40 per cent basis, that is, we schedule 40 of the available man hours leaving the 60 per cent balance for emergencies. In some shops today we are able to schedule as high as 80 per cent of the shop hours, finding that 20 per cent cushion is sufficient to handle emergencies. We believe it is better to schedule our shops with this cushion rather than revise the schedule and defer some work because of an emergency.

Responsibility—We are slightly in disagreement with Mr. Fuller in connection with the responsibility of the maintenance planning group. We feel that the planning department is responsible for "when" and "what." We believe that the shop foreman should be responsible for the "how" and "where." Incidentally we are functioning on this basis and have experienced little conflict.

In conclusion, I believe that the opportunities for cost reduction through maintenance planning are greater today than ever. Also that the service which can be rendered by maintenance shops to the various operating groups can be improved. I would caution against establishing maintenance planning on a too elaborate basis. It is quite possible that an organization of this kind can be developed to such an extent that it tends to weaken the shop organization and defeats, at least in part, the very purpose for which it is established. We are not too interested in coordination between shops, our desire at present being principally to perform the functions within a shop efficiently.

E. L. Stentz: I sort of sympathize with Mr. Fuller for having to present this particular problem, because a lot of these moves that he shows up here on his elaborate chart are merely handing a piece of paper to the next man, but he has to show it in order to show how it gets there.

I think he has given you a rather complete analysis of a maintenance machine shop scheduling problem and the method that he uses in controlling that problem.

Naturally, the methods for shop scheduling vary from plant to plant and are governed by organization, geographic locations, personalities, and equipment. Regardless of the size of your shop, an analysis of the problem will convince you that the principles that Mr. Fuller has outlined, both for maintenance planning and shop scheduling, are applicable to your shop, but it is obvious that unless the conditions he enumerated above are comparable to Mr. Fuller's setup, the physical operation of the schedule will be different. For example, it is possible to combine the control clerk and schedule clerk in a smaller shop. The material movers, shop shipper and department shipper can be correlated under one group; and the dispatching to meet schedules can be performed from a central control rack on the shop floor by the use of the order folders which eliminate several forms if the size of the shop permits such combinations. Nevertheless, every function as outlined by Mr. Fuller is necessary for shop scheduling. His caution to use the details that he outlined only as a guide is timely, because you can build an organization that is too big for your particular application.

We at our plant have gone through the formative period and developed what we think we need. We firmly believe that maintenance shop planning and scheduling is a necessity, but we also realize that the economies are based primarily on the service rendered as a tool in the integrated operations of the department and plant, and we have taken great care in attempting to use only those functions that best fit our needs.

I heartily endorse Mr. Fuller's remark that no system is a reasonable substitute for the ability of the shop management. Also, I endorse his statement that the success or failure of the control will depend entirely on the shop supervisors, as they must make it work. It will not be successful by its merits alone.

I might summarize our ideas of shop scheduling by stating that every detail Mr. Fuller has mentioned must be performed in any shop by someone, at some time, on every order, and if all these details are performed systematically, with forethought, the shop can give the maximum service for which it is intended.

E. J. Moxley: There is no system of scheduling that you can put in any shop that will be successful unless somebody makes it work, and that has been one of my great difficulties. The success or failure of any scheduling system will depend upon the human element, the attitude of those people who have to do with that system. The way we did things forty years ago seems to be sufficient to some of our shop operators, which is not true today.

We have tried in our shop, several times, different systems of scheduling. We do not have a very large shop, of course, and I would like to ask Mr. Fuller this question in that connection. Take a machine shop, for instance, in which there would be about 400 men employed; about what amount of personnel would your scheduling department consist of?

L. E. Fuller, Jr.: That depends on whether you are talking about the maintenance planning organization, which controls all the shops, or the scheduling force within any one shop.

E. J. Moxley: Let us take it from the standpoint of scheduling all shops, because they are all more or less interlocked one way or the other, the foundry and blacksmith shop especially with the machine shop.

L. E. Fuller, Jr.: The maintenance planning organization, which includes spares control and material handling and storage, consists of approximately 77 people. Actually, the spares control function and the material handling function are not directly related to shop scheduling. These are functions that have been assigned to the planning office over and above those required to schedule the shops.

The situation is somewhat like this: the planning office has control of two storage yards that maintain all of, what we call, raw material for use in the shops, that is, all castings, forgings, plates, slabs, billets, blooms, etc. Actually, the personnel in these functions should not be included with the personnel required to schedule the shops. If you remove the personnel on spares control and material handling from the planning organization, it will leave a scheduling force of approximately 35 people.

In our machine shop, of course, the force is considerably smaller. Including all of our material handlers and routers, the total scheduling force will not exceed about 10 people. Our standard crew in the shop is 552 people. At present, we are running around 500 people.

E. J. Moxley: That clears up one question in my mind. Also, I want to thank Mr. Gravenstreter for his figures, which demonstrate to me that proper shop scheduling will certainly result in a reduction of man-hours per job. I doubt very much whether that angle of it has been given too much thought among many shop operators in steel plants. That, to me, means a lot.

E. L. Stentz: I did not expect this question of crew sizes to come up, but I can see it is causing some anxiety and I would like to tell people who have not tried this business that I made a rather complete survey of the number of people, in other words, on the basis of the man-hours of service before and after such an installation, and then made a survey of the number of people serving the tradesmen in shops that did not have this, and I was quite pleased to find that the ratio with the planning organization of the service people, such as clerks, material handlers, schedulers, and so on, is smaller with this type of organization than it is without it.

That may sound strange, but we were forced to make such a comparison if we were going to continue with our particular type of planning; and in addition to that, we have also found the same benefits in man-hours per job, primarily based on the elimination of lost time between operations that Mr. Gravenstreter has pointed out.

Fred C. Schoen: I have one or two questions. As I understood Mr. Fuller's paper, the promises for the schedules were set up in the shop and the promises were returned then to the central planning department. I can understand how that would work nicely in a maintenance shop, but as I understood the paper, there is outside customers' work going through those same shops. If you are sending down to the shop for a promise on an inquiry, what does it do to your schedule? We will say the inquiry returns and you make a good promise on it; at the time the order is actually placed your promise is rather badly shot. How can you take into account a problem of that type?

There was another item that I was not clear on. You spoke of a preference list, No. 1, 2, or 3, as I recall, and in a shop where you are supposed to sort out jobs and put them in the preference list 1, 2, and so forth, if No. 1 keeps coming along all the time, how do No. 2 and No. 3 ever get machined?

L. E. Fuller, Jr.: In reply to your first question relative to outside customers, any time a promise date is set up on an inquiry from an outside customer, it is always predicated on receipt of the order, and is subject to change on that basis. For example, during the war we were doing a great deal of outside work and would get an inquiry, or a representative would come into the plant asking about delivery dates. In some cases we did not receive the order until two or three months later. Obviously, we could not maintain a promise on that date. If we develop a promise predicated on having the order, then logically we do not run into too much trouble in maintaining that date, but we must have the order to activate any promise that we make.

Second, a discussion of the preferential order sequence is something that is very debatable. I did not want to go into it too deeply, but I will give you some idea of how it works. Actually, there is only one preference list. This list is developed by what we call "ordering responsibilities," that is, the mill departments, and the list is kept up to date every week.

As the mill departments add new orders or send new orders into the shop, they are added to that list and must be given a preference number. It may very well work in this way: they have a list that has a No. 1 job, and the following week they will send in another order which they now want as No. 1. Obviously, the previous No. 1 job must drop down into some other sequence. They have to establish that sequence. It may change a No. 1 job to a No. 10, but the list must be activated constantly in order to eliminate the problem that will generally arise when you have five or six No. 1 jobs from the same responsibility.

You will run into this problem if your organization is set up somewhat along the line of ours. We have a superintendent of rolling mill maintenance who controls five rolling mill maintenance units. From each one of those units you will get a No. 1 job. If that creates too much confusion in attempting to process all No. 1 jobs, as sometimes or other they are liable to go on one machine, then you can change your preference list routing to place the responsibility upon the superintendent of the division to establish a No. 1 job for the entire division. By that I mean he takes the five No. 1 jobs from his five units and establishes a No. 1 job for the five, and 2, 3, 4 and 5 in that order. That will, of course, eliminate the great number of No. 1 jobs.

Actually, in a large shop if you have a considerable variety of machine tools, you can take a No. 1 job from each of the various ordering responsibilities and can operate pretty well on that basis without running into too much confusion. It is very seldom that you will have two jobs that are of the same preferential listing together in the same machine. But if you do run into confusion that way, the more you narrow the list down, the easier it is going to be for you.

Preventive Maintenance

By E. L. ANDERSON, Superintendent
Electrical Department
Bethlehem Steel Company
Johnstown, Pennsylvania

E. L. ANDERSON

. . . . maintenance of equipment should start with the original design and specifications, and should be taken into account when the operational procedure is established . . . .

▲ WITH the ever increasing cost of materials and labor, the problems of operating an economical maintenance program become more and more complex and require a high degree of cooperation between management, operating departments, engineering department and the maintenance department for their efficient solution.

In the building of a new plant or making major changes and improvements to an old plant, preventive maintenance starts on the drawing board in the engineering department. In this department, the proper cooperation and exchange of ideas between the operating department and maintenance departments, both electrical and mechanical, can result in the design of equipment and specification of material which will give good operating performance at a reasonable first cost and at the same time provide an installation that will require only normal maintenance. With such cooperation, new ideas, new equipment, new methods can be considered and compared with operating and maintenance factors experienced with similar equipment that has been operating possibly for a number of years. Weak and troublesome points can be eliminated and a clear cut installation, satisfactory to all concerned, can be the result.

An installation worked out on this basis, with electrical equipment of ample capacity, lubricating systems, adequate lighting, etc., and with easy access provided to all parts for normal inspection and repairs, will result in low maintenance.

The older plants present a different problem, and protective maintenance in these cases has to be approached from a different standpoint. With the ever increasing demand for production, equipment designed and built twenty-five to thirty years ago is called upon to accomplish operations beyond its capacity, operations for which it was never designed. In many cases, motors, controls and other equipment are now obsolete, but at the same time it is often economically impossible to replace them with modern equipment. Cranes in particular fall into this category. The old cranes were of light construction, as were the runways. Sleeve bearings were the order of the day, with soft steel and cast gearing throughout. Yet these cranes are still giving good service and with a reasonable amount of revamping can give good service for years to come.

Lubricating systems can be installed, heat treated and cut gears used to replace the soft steel and cast gearing. Manual controls can be replaced with controls of the magnetic type. Mechanical load brakes can be removed and dynamic lowering hoist control applied. Motors can be changed from sleeve to anti-friction bearings and the use of oversized coils in the armatures of mill type motors will increase the life materially. Class B insulation on coils is another improvement that can be made. Most of the manufacturers are working on these problems and have made available materials and equipment to help with the program of reduced maintenance.

A small motor-generator built to increase the voltage 10 per cent from 230 to 250 d-c, on a magnetic clutch connecting a 2000 hp motor to a wheel rolling mill has resulted in an increase of 500 per cent on the lining life of the clutch, a big reduction in mill delay and a better product from the mill because with the higher voltage the clutch engages more quickly and positively. These are a few of the many things that can be done to aid in preventive maintenance.

Periodic or scheduled inspections and checks on equipment are a big factor in preventive maintenance. There have been quite a few articles devoted to this subject so it is not my purpose to recommend any speci-

Presented before AISE Pittsburgh District Section Meeting, April 12, 1948.

fic suggestions as to what should be done in this respect.

A few of the major points that we make a concerted effort to observe, are as follows:

1. Inspection of turbo-generator units every two years.
2. Annual test of all transformer oil to see that the dielectric strength is of proper value.
3. Annual inspection of all pole lines and transmission lines. Special attention is paid to line hardware, as links and other parts, even though galvanized, will eventually deteriorate.
4. The checking of ground resistance of towers, lightning arresters and other equipment annually, preferably in the spring, before the electric-storm season.
5. Checking, cleaning and spraying main motor equipment every 12 to 18 months.
6. Periodic cleaning of high-voltage switching equipment, transformer bushings, etc.
7. Monthly inspection of all overhead cranes by one man assigned from the maintenance department office.

It is impossible to set down any fixed schedule that would fit all conditions in any plant. Each plant must be handled as a separate unit and schedules set up to suit operating and other conditions.

Proper lubrication is an important factor in preventive maintenance. Equipment properly lubricated will give long, trouble-free service.

In addition to the above, there are one or two other items which are more important to preventive maintenance than anything that has been discussed.

You can have the finest and best built plant, you can make all the changes to and inspections of equipment you want, but if you do not have good housekeeping, your efforts are at naught; for good housekeeping is the key to preventive maintenance.

By good housekeeping is meant a clean and orderly plant, equipment that is clean and in order, spare parts that are painted and maintained in an orderly fashion. Spare motors, shafting and other large parts should be stored under a crane or made accessible to other material handling devices so that they are available at a moment's notice. Small parts should be kept separate and stored in bins.

A clean and orderly plant is not only a more pleasant place to work in but it usually enjoys a good safety record.

Good housekeeping, safety, and preventive maintenance go hand-in-hand.

There is one other problem which is next to good housekeeping in importance and that is the prevention of damage to and abuse of equipment. Costly breakdowns, delays to operation and the disruption of normal maintenance schedules are the price paid.

There are several factors that enter into this damage and abuse problem. Some of these causes may be listed as follows:

1. The improper training of operators.
2. Carelessness on the part of operators.
3. Failure of supervision to enforce rules governing the operation of equipment even if it means disciplining an employee.
4. Using equipment for purpose other than that for which it was designed without any regard to the consequences. Side pulling with overhead cranes, using soaking pit and stripper cranes to move long lines of cars, overloading scrap boxes on open hearth charging machines are some of the "easy" ways of doing things which result in high maintenance cost.

The elimination of such conditions can best be accomplished by the close cooperation of the operating department.

In conclusion, I would like to summarize the points which if followed will result in "Preventive Maintenance":

1. Close cooperation of management, engineering, operating and maintenance departments in preparing plans and specifications.
2. In old plants, the continued revamping or replacing of equipment. Use of heat-treated gears, changing over from sleeve to anti-friction bearings, etc.
3. Periodic or scheduled inspections of major equipment.
4. Good housekeeping.
5. Elimination of abuse and damage to equipment.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill", published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

REHABILITATION OF EXISTING PIPE LINES

By ALFRED B. ANDERSON, Chief Engineer
Water and Sewer Division
Pittsburgh Pipe Cleaner Company
New York, New York

. . . . an additional tool now available to the maintenance man is the ability to coat pipe lines in place, thus preventing hydraulic deterioration of the line . . . .

▲ MANY engineers in charge of water distribution are cognizant of the depreciation of pumping equipment, and other mechanical installations, but very few actually consider the cost of corrosion in the pipe itself. Little, if any, thought is given to safeguarding the huge investment in the hydraulic capacity of the pipe lines.

This is primarily true in the industrial field where the water system is only one of several utilities necessary to the manufacture of the finished product. In this instance, the actual cost of the water and the obsolescence of the system are so grouped in the accounting system that actual figures are unavailable.

How may we determine the cost of this obsolescence due to corrosion? To be sure, it will vary with the activity or corrosiveness of the water and each case will present its individual problems.

The answer to the question is, a hydraulic study of the water system. Serious and expensive errors are often times the result of misinformation and haphazard assumptions. For example, one engineer was faced with the problem of expansion in his plant. In order to determine the present capacity of his system, he consulted the Williams & Hazen tables and selected the coefficient indicated in the proper age group, concluded that he had ample capacity and proceeded with the construction of an extension to his system. When completed, there was an insufficient supply which proved quite embarrassing.

The cause of the deficiency was in the selection of the coefficient. The water in this system was much more corrosive than the average from which the Williams & Hazen coefficients were prepared. In some cases, the actual loss of carrying capacity in certain sizes of mains after 30 years of service may be twice that predicted in the Williams & Hazen tables.

In another instance, we have information regarding one open hearth group where additional water was required for cooling purposes. A considerable amount of money was invested on additional pumping equipment, not considering the existing condition of the pipe lines. The increase in delivery of the system after the installation of the new pumps was so slight that it is hardly worth mentioning.

Surveys of water systems are necessary and useful for several reasons. They provide data for future design and present operation, they indicate improvements that can be made in the existing system, the hydraulic adequacy of the pipe lines and the pumping equipment can be determined, they provide data for the proportionate distribution of pumping costs within a plant together with furnishing information invaluable in the determination of industrial wastes for sewer design.

In addition, hydraulic studies indicate the annual increased pumping costs due to reduced hydraulic efficiency caused by corrosion.

Although hydraulic studies of water systems are not within the scope of this paper, the subject is mentioned because, by such a survey, the actual capacity of a system can be determined, the cost of corrosion is a factor that can be determined, and the advisability of rehabilitation definitely established.

When one considers that the cost of laying pipe for the distribution of water in the average system costs approximately ⅔ of the total value of the installation, and 80 per cent of this value is represented in the mains and valves, it seems reasonable to assume that it is good business to protect this investment against corrosion.

Our company has been cleaning water pipe for a number of years. The management realized, however, that the removal of the corrosion was only a temporary expedient and that the operation would have to be repeated periodically in order to maintain the capacity of the pipe lines. In order to preclude the necessity of periodic repetition of the cleaning operation it became necessary

Presented before AISE Pittsburgh District Section Meeting, April 12, 1948

to find a method of recoating the pipe in the ground after cleaning.

Briefly stated, the method must be such that the coating could be applied on a wet surface which is inaccessible, the coating must be insoluble in water after the application, it must be readily applied, tasteless, odorless and non-injurious. It must also resist the flow of water immediately after application and the process must be such that positive indication of the completed coating of all exposed iron is afforded on the ground surface. A method of coating water pipe in place was developed and perfected by an English company some fifteen years ago. It has been commercially successful and over 3,000,000 feet of water pipe have been coated by this process.

Although this method of restoring and maintaining the hydraulic capacity of water lines is comparatively new in this country, a number of contracts have been successfully completed. These contracts have varied from the rehabilitation of an entire municipal distribution system to the rehabilitation of single supply lines. The benefits derived from this work can best be shown by an actual case. One contract called for the cleaning and relining of 17,000 odd feet of 24 in. cast iron water main. The Williams & Hazen coefficient before processing was 69 and the delivery 5.6 million gallons per day. After cleaning and relining, the coefficient was 130 and the capacity increased to 9.3 mgd.

The process is an electrolytical method of depositing an especially prepared bitumen compound from an aqueous solution on the pipe interior. In principal, the method resembles the well-known copper or silver plating electrolytic methods, with the exception that the plating material is taken from the electrolyte.

Before the coating operation can be undertaken, the pipe must be thoroughly cleaned. The cleaning tool must remove all rust, tubercles, deposits, loose or deteriorated remains of original coating and all other foreign materials from the inside of the pipe.

To accomplish this, an entirely new sectional cleaning machine has been designed. Ploughs, scrapers, and wire brushes under high pressure break away the deposits, dig out the pits and brush the interior of the pipe in one operation. The design of the equipment is such that it allows "on the job" adjustments to meet varying field conditions. The number of passes required to thoroughly clean the pipe varies with the condition of the pipe interior. About a year ago, a 12 in. salt water line was cleaned and coated by this process. The interior of the pipe contained 2 in. of corrosion and $\frac{1}{4}$ to $\frac{3}{8}$ in. of graphitization. In order to produce a clean, hard surface to which the coating would adhere, it was necessary to pass the cleaning machine through this line seven times. Needless to say, this was an unusual condition.

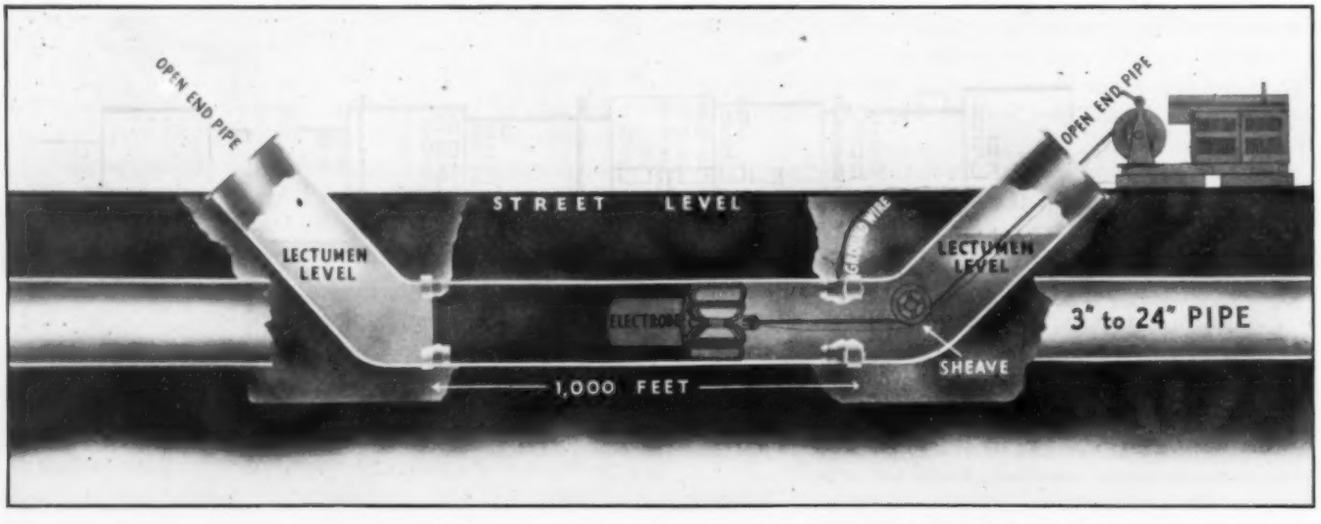
In pipe sizes up to six inches in diameter, a semi-hydraulic cleaning method is used. This consists of drawing the cleaning machine through the pipe with power winches and flushing. Pipes of eight inches diameter and up are hydraulically cleaned. The cleaning equipment is inserted in the pipe and the impact of the water against the cups propel the machine through the pipe with a predetermined amount of water allowed to pass through the tool for flushing purposes.

The spring steel arms of the cleaning heads are so designed that a maximum force of 250 lb will be applied against the cleaning tools in contact with the pipe wall. The arms are staggered in such a fashion so that, when the cleaning head is in the pipe, some portion of the cleaning tool is in contact with the entire circumference of the pipe.

Usually cleaning is done in long sections which are later broken down into shorter divisions usually not exceeding 1,000 feet for coating.

The equipment necessary for processing includes electric generating equipment, pumps, pipe cutting tools, tanks and incidental accessories. In preparing a section of pipe for coating, all connections, taps, etc., within the limits of the work are shut off and special fittings attached to the ends of the pipe to contain the coating material.

Figure 1 — In coating pipe in place, the coating material is poured into the pipe so that the pipe is completely filled with the material. The electrode is then drawn through the pipe and as the electrode moves, coating is applied in that particular section.



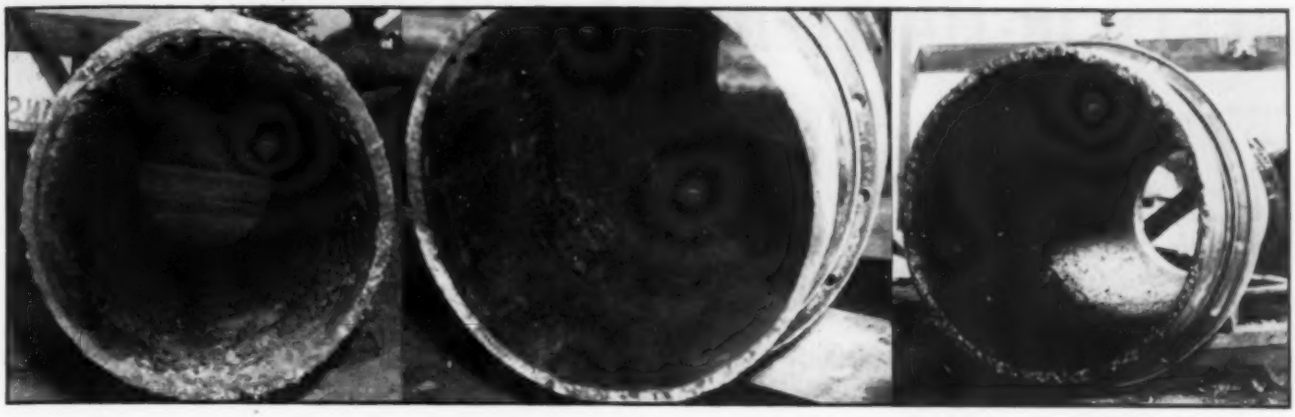


Figure 2 — Left, this 24 inch main had a coefficient of 69 before cleaning; center, the coefficient of the pipe was increased to a value of 134 after cleaning; and on the right is shown the main after the pipe has been cleaned and coated.

A rubber swab and wire brush section are then drawn through the pipe as a final precaution to remove any fine particles of material remaining in the pipe. Next, the electric cable and wire towing rope are threaded through the line and the cathode attached at the far end. The pipe is then filled with an emulsion of bitumen, and the electrical circuit completed by connecting the electrode to the negative pole of the generator and the pipe to the positive pole. The ammeter and voltmeter are included in the circuit.

When the circuit is completed, coating starts immediately. The current flowing from the pipe to the electrode sets up negative charges in the molecules of bitumen, which in turn flow toward the positive pole—the pipe. Molecules of bitumen are uniformly deposited on all metallic surfaces within the field. Coating is completed when a sufficient thickness of bitumen is deposited to prevent the passage of current between the anode and cathode. The ammeter and voltmeter readings constantly reveal to the operator the exact condition of the processing. When the current is reduced to a practical zero, the cathode is drawn forward a distance equal to its length by means of manually or power operated winches attached to the generator and the procedure is repeated until the entire line is coated. The bitumen emulsion is then pumped from the pipe and the line flushed for a short period to remove any excess emulsion that may remain in the pipe. After flushing, the line is ready for service.

While this explanation illustrates the principle involved when the cathode is stationary, the continuous coating operation varies somewhat in actual practice. However, the same principles hold true in either case and the process is instantly controlled by the instrument board.

The forward movement of the cathode is predetermined and its speed is based on the size of the pipe, plus other calculable factors. The rate of travel of the cathode depends on operating conditions and varies from two to six feet per minute, depending on the size of the pipe.

All metallic areas, and even lightly coated sections of old non-mineral coatings on the pipe interior are completely covered with bitumen. The coating is tough and will not crack. It adheres tenaciously to the pipe wall where it has been evenly and smoothly deposited.

The economy of this process can best be explained by the following facts affecting cost.

1. Maximum lengths of pipe that can be coated are as long as 1,000 feet and, under some conditions, this may be extended.
2. A line is out of service for short periods only.
3. Corporation taps, cross connections, or other fittings are not dug up nor exposed. The bitumen emulsion is flushed out after coating.
4. Pipe is immediately available for use after coating process is completed. A few minutes of flushing is required before restoring pipe to service.
5. The method is virtually fool-proof. No possibilty exists whereby a main can be blocked. Thus, mains can be rehabilitated in conjected areas with confidence.
6. In reconditioning transmission mains which must be kept in operation, temporary lines are laid.
7. The electrolyte is an emulsion of bitumen and does not require a dry pipe.
8. The process deposits a smooth, even coating of bitumen over the entire pipe interior, which will retain its high carrying capacity for many years.
9. Coating does not materially reduce the cross-sectional area of the pipe.
10. Coating imparts no taste or odor to the water and is non-injurious.

The cost of rehabilitating pipe lines varies considerably with conditions. Generally speaking, a main can be rehabilitated for approximately ¼ of the cost of laying new pipe. A guarantee of producing and maintaining a delivery of 95 per cent of the original carrying capacity of the pipe is usual. Where original carrying capacity figures are not available, a suggested method is to clean the line thoroughly and then test it. The results of this test are accepted as the value of the line when originally laid.

Under proper electrical and soil conditions the life expectancy of cast iron pipe is increasing each year. The obsolescence of the pipe due to corrosion can be corrected by the process. Thus, a new field of thought is presented to the operators of water systems, namely, rehabilitation rather than replacement.

SAFETY IN MAINTENANCE AND CONSTRUCTION

. . . . probably no one factor has had more effect on the reduction of industrial accidents than the development of safety standards . . . .

By DAN FARRELL, Supervisor of Safety
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

▲ THROUGHOUT American industry, production and distribution have been advanced immeasurably by widespread adoption of standardized tools, materials, and methods. Likewise, the science of accident prevention has been made more effective through the development and acceptance of safety standards.

This trend to uniform nomenclature in specifications and method descriptions started before the nation's safety forces were joined in a formal organization. The idea gained strength after the first World War and greater progress was made in recent years when the urgency of the world conflict unified all industry and made the adoption of standards a vital necessity.

With such widespread recognition of the practical value of standards for safety, more studies, the objective of which are the development of uniform standards, are now under way than during any previous period.

Developments in safety standards in the maintenance field have also reached new heights. Time does not permit us to discuss in detail these many developments but we should like to discuss several of the more important ones.

For example, safety belts and harnesses were first considered only as standard equipment for window washers and power and communications linemen. Now they are being used widely throughout industry. This widened use of safety belts led to studies which resulted in the development of equipment standards. Conditions requiring their use played a big part in this development. Belts worn by individuals entering a tank or bin, for example, should have a lanyard fastened at the back of the shoulders or over the head so that the men can be lifted vertically and brought out through a manhole.

On the other hand, webbing used around chemical operations should be heavily impregnated with rubber. Under damp conditions it should be heavily waxed to prevent rotting from mildew. The strength of the harness and the rope used for working in tanks and bins need not be high but belts that may be required to check a fall demand greater strength. The care of the belts is as important as proper selection of the material of which they are made. Trained individuals familiar with standards should check belts at least every one to three months.

Another standard worthy of emphasis is that applying to ladders and scaffolds. The National Safety Council statisticians tell us that one-third of the injuries are traceable to scaffolds and platforms occurred while employees were erecting, dismantling, or adjusting the scaffolds. From studies of reported accidents, definite standards for ladders, scaffolds, and platforms have been developed.

Although many companies have adopted these standards, many unsafe conditions continue to exist, such as the absence of guardrails, insecurely fastened bracing and planks, defective material, material of insufficient strength and improper application. To reduce these conditions, the testing procedure recommended is that the plank first be carefully inspected to make sure it is suitable for such use by determining the safe center load for a plank of a given size. Tests should then be made with twice the load, and if there is any indication of failure that can be seen or heard or if any obvious deflection remains after the removal of the load, the plank should be rejected. Scaffold requirements according to recommended standards are as follows:

1. Scaffolds should be designed to carry four times the anticipated load.
2. All scaffolding should be built and dismantled under competent supervision.
3. Only sound material should be used.
4. Standard railings should be provided on all scaffolds when they are to be used at 6 feet or more from the ground.
5. Toeboards should be provided on all scaffolds and should extend at least 5½ in. above the scaffold floor.
6. Access by stairways, ramps or fixed ladders should be provided.
7. Debris chutes should be provided where needed.
8. Overhead protection should be provided where men work or where pedestrians pass below a scaffold.
9. Scaffolds should be inspected before use and reinspected frequently.

Getting from one level to another involves a certain amount of risk to maintenance employees. A study of recorded accidents involving the commonplace ladder has led to the establishment of extensive standards, both in their manufacture and maintenance. The condition of all ladders should be recorded. Among things to look for are: loose steps or rungs; loose nails; screws, bolts, or other metal parts; cracked, split or broken braces, steps, or rungs; slivers, damaged or worn shoes. Storage of ladders is important. They should not be

Presented before AISE Pittsburgh District Section Meeting, April 12, 1948

stored where they will be exposed to weather nor should they be stored near radiators, stoves or steam pipes. In addition, two coats of linseed oil or spar varnish should be applied to increase resistance to weathering while in use. All ladders found to be defective on inspection should be marked and taken out of service. No one should be permitted to use them until defects have been corrected. If beyond repair, ladders should be destroyed promptly.

A safety program involving ladders should include the following:

1. Inspection of each ladder as soon as received.
2. Setting up a routine for regular and thorough inspection.
3. Keeping a record for each ladder. It should include:
   a. Date purchased or built.
   b. Date of inspections.
   c. Condition and needed repairs.
   d. Dates for next inspection and recoating.
4. Record system may be supplemented by stenciling on ladder a date to indicate when next inspection is due.
5. Instructing men to observe precautions and to report any defects before using ladders.
6. Examining to determine whether an employee is physically and mentally adapted to work at high levels before assigning him to work on ladders.

The hard hat is a necessary item of personal safety equipment to many maintenance people. Such headgear must be designed not only to protect against impact but must be fire-resistant and should be non-conductive if contact with live electrical equipment is probable. Helmets should be impervious to moisture from the weather or from sweating to insure against softening.

A hard outer shell protects against impact, as the hammock or cradle supporting the shell keeps it away from the head and cushions the impact of a falling object or blow. Several standardized tests have been developed. One test specified is the dropping of an 8-pound spherical weight from a height of 5 feet. The hat must withstand this impact without breaking or denting sufficiently to touch the inner side of the cradle or the hat block upon which it is placed. Another test drop is made by permitting a 16-ounce carpenter's plumb bob to drop from a height of 10 feet and strike directly on the crown. The crown must not be dented or pierced more than $\frac{7}{16}$ in.

Electrical resistance is tested by subjecting the hat to a potential of 2200 volts at 60 cycles.

Cradle and sweatband should be detachable and replaceable, both because of deterioration when exposed to perspiration for long periods and for sanitary reasons, especially when hat may be worn by more than one person. The shell can be sterilized by any of the common methods. A hat with a brim all the way around provides the most complete protection for the head, face, and back of neck.

Standards in themselves mean nothing. Let us consider for a moment for whom they were designed. Can you think what a standard we are considering today would mean if we failed to consider industrial man. We protect him with standard equipment and facilities. However, in the performance of his job lies a vast field for the exploration and standardization of those acts he performs, which can either insure his well-being or lead to injury.

If we do not make the most determined effort to study his acts, we can make here and now the blunt statement that "future progress is hopeless." Within an occupation are the duties performed by an individual and it is in the performance of these duties that the acts involving injury are to be found. Although there may be a different terminology insofar as occupations are concerned, frequently the duties performed within several occupations may be of a somewhat similar nature. For example, material handling is common in many occupations but the manner in which the material is handled may vary to the extent that it is handled by hand, by crane hooks, or by hand tongs. These differences require that each situation be considered on a separate basis and research must be applied to discover the particular act from which an injury can stem.

Through the utilization of standardized material factors and the development of safe repetitive work habits, which are likewise standard, industrial man can virtually be freed from fear of accidents or injury and can find within his job the expression and accomplishment he seeks.

AISE DETROIT DISTRICT SECTION

Tenth Anniversary Meeting

OCTOBER 12, 1948

FORT SHELBY HOTEL
DETROIT, MICHIGAN

DINNER - 6:30 p. m.
MEETING - 8:00 p. m.

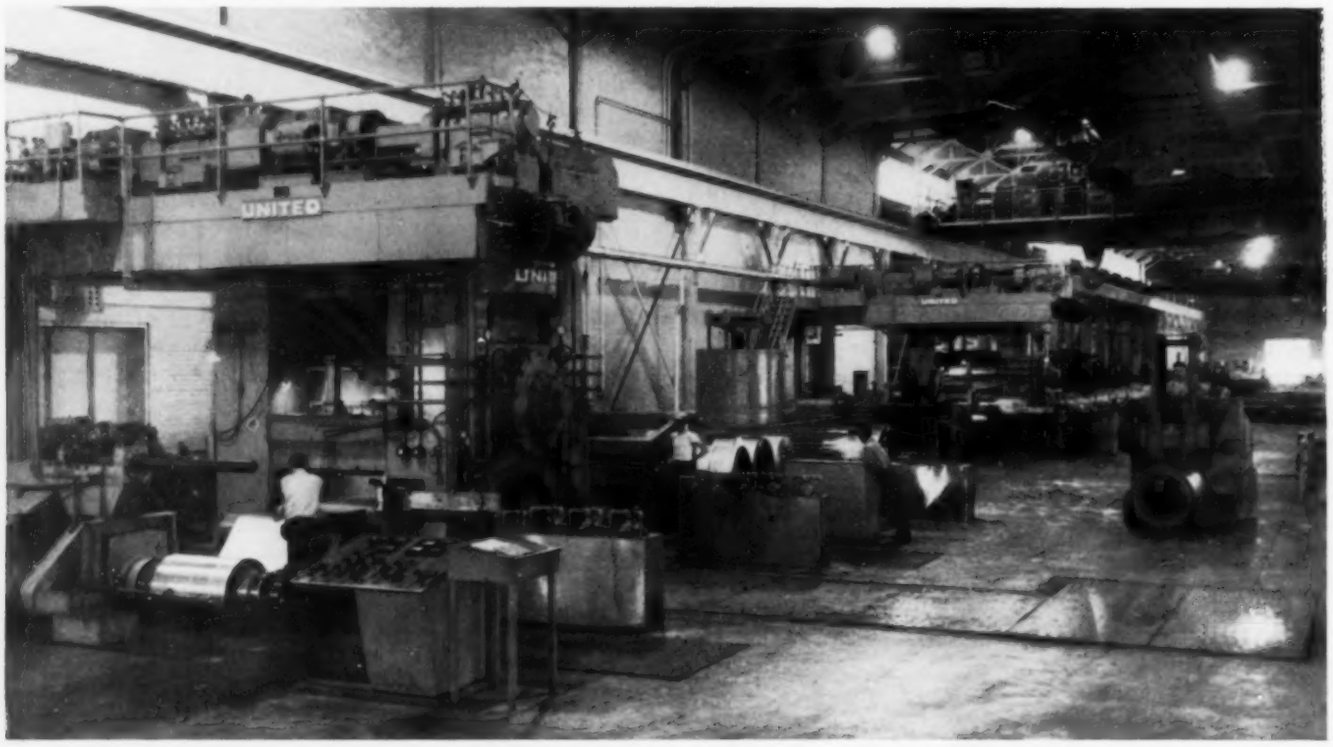
"INCREASE IN STEEL PRODUCTION"
BY
JULIUS A. CLAUSS, VICE PRESIDENT IN CHARGE OF ENGINEERING
GREAT LAKES STEEL CORPORATION

A special program has been arranged in honor of the founder of the Detroit Section, Julius A. Clauss, and the original group of members who joined together to form this section in 1938.

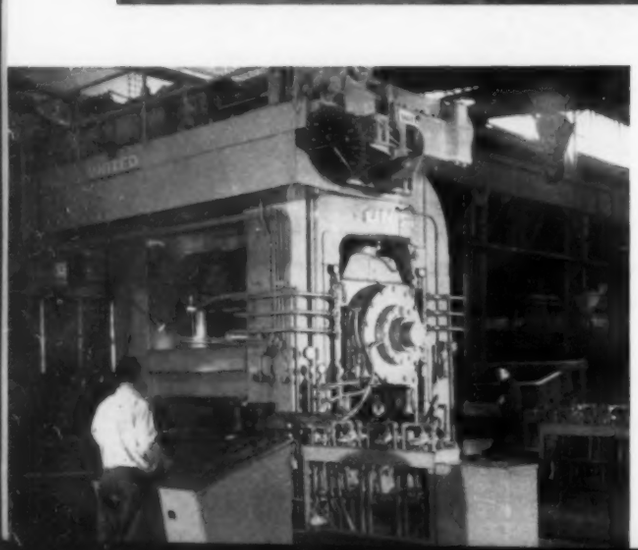
REPUBLIC EXPANDS STAINLESS FINISHING CAPACITY

Now in production, Republic Steel Corporation's new Enduro Plant No. 2 in Massillon, Ohio, substantially increases Republic's capacity for stainless sheets, particularly in the greater widths. The new plant supplements facilities known as Enduro Plant No. 1 where flat rolled stainless steel in widths up to 30 in. is processed and finished. This No. 1 plant, which was described in detail when it started into production (AISE Yearly Proceedings, 1940), has been modified somewhat by a revamping of annealing-pickling lines, and the addition of two new annealing-pickling lines and a shearing line. A Sendzimir mill is to be added in the near future.

The new stainless facilities of Enduro Plant No. 2 are installed in these buildings, which originally housed a sheet mill, and more recently, an armor plate plant. Major items of equipment now installed include four breakdown and five intermediate and finishing anneal and pickle lines of various widths, three four-high cold mills, four slitters, two cut-up lines, and two inspection benches.



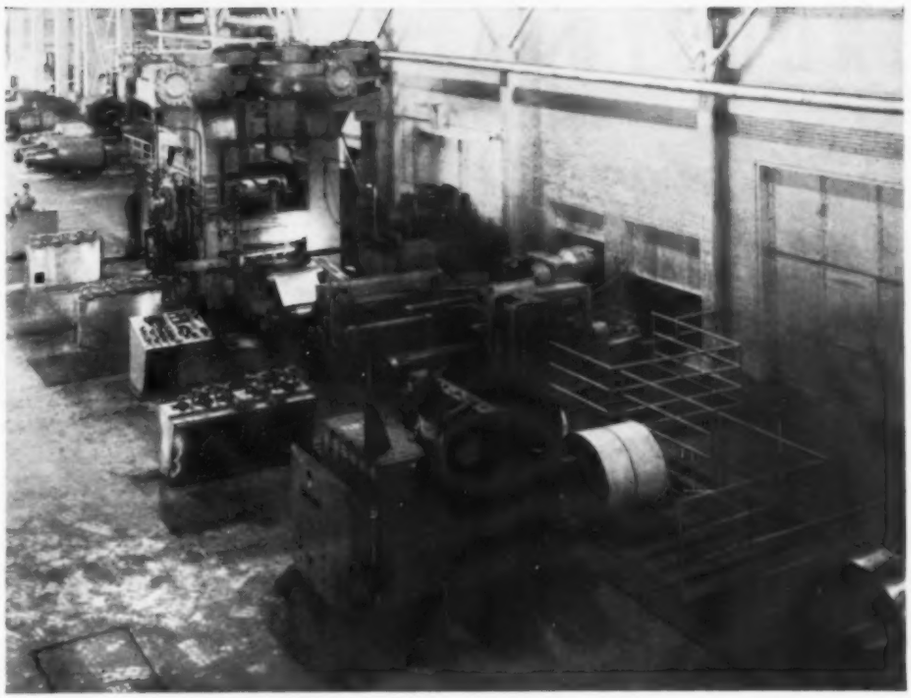
These two four-high reversing cold mills roll stainless steel coils in widths up to 60 in. Coils of 20 in. inside diameter, and up to 44 in. outside diameter may be handled. Hot rolled strip up to .30 in. thick may be reduced to as low as .015 in. gage in several successive steps of reduction with intermediate annealings and picklings. Each reduction step may consist of approximately seven passes. There is also a 20½ in. and 49 in. x 66 in. four-high skin pass mill, driven by a 700 hp d-c motor, to improve strip surface and impart the desired temper after the final annealing and pickling.



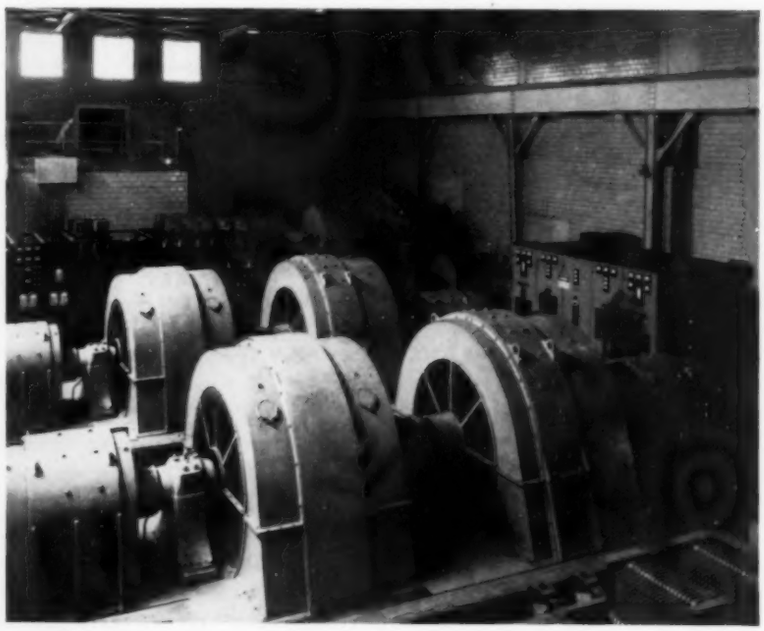
This 16½ in. and 56 in. x 66 in. mill rolls stainless steel in widths up to 60 in. It is driven at speeds of 250-500 fpm by a 2000 hp, 300-600 rpm, 600 volt d-c motor. Work rolls operate in roller bearings, and back-up rolls run in oil-flooded bearings. Hydraulically operated expanding reels are provided on each side of the mill.

This view of the 16½ in. and 56 in. x 54 in. mill shows the floor-level conveyor which feeds coils up to the mill. Before receiving its initial pass in the cold reduction mills, the steel passes through a five-roll leveling unit. Industrial trucks are widely used to carry the coils.

This mill is driven by a motor duplicating that used on the 66 in. mill.



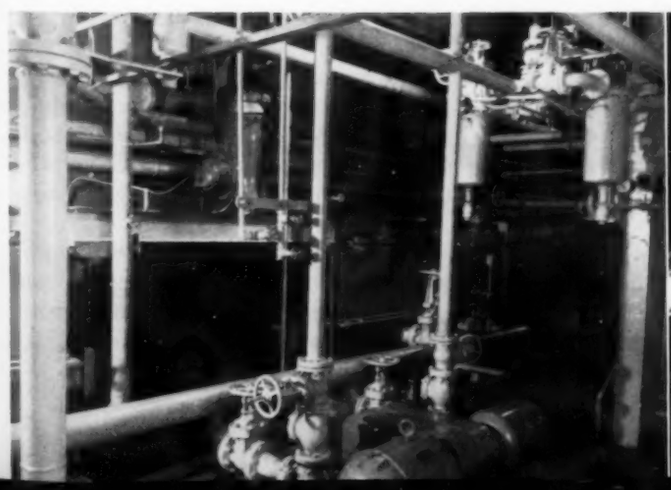
(Below) Each of these motor generator sets supplies direct current to one of the cold reduction mill drives which operate under adjustable voltage control. The 66 in. mill drive may be seen in the far corner of the motor room. The drive for the 54 in. mill is in the corresponding corner to the right of this photograph.



After the intermediate annealing and pickling, the stainless strip is interwound with paper to protect its finish. Here the paper is being reclaimed for further use as the strip is again passed through the cold reduction mill.

Shown below is only a small part of the equipment installed in the basement of the cold mill building to provide lubrication, roll cooling and hydraulic service to the 54 in. and 66 in. cold reduction mills.

Polishing machines in the No. 1 Enduro plant are used to put a variety of finishes on the stainless sheets. Extreme care is necessary in this final operation to protect the finished surface.



INDUSTRIAL TRUCK

Storage Battery Maintenance

By R. E. MILLER, General Foreman, Sheet and Tin Division
Bethlehem Steel Company
Sparrows Point, Maryland

. . . . careful attention to battery maintenance and operation of the battery charging station will increase the number of full cycles that the battery will operate . . . .

▲ A good maintenance program for industrial truck storage batteries cannot be carried out unless some thought has been given this problem when planning the battery charging station. The number and type of trucks or tractors in the fleet, and their duty cycle, must be known before the size and number of batteries necessary for continuous operation can be determined.

Industrial truck manufacturers, if given all available data on weight of loads, distances to be traveled, per cent grade of ramps and floor conditions, will specify the size of battery necessary to give six hours continuous operation before a change of battery is necessary.

Assuming the charging equipment is to consist of a motor generator and individual charging panels, the size of generator and number of panels necessary to assure fully charged batteries at all times can be determined only after careful study of the duty cycle of each individual truck, or group of trucks.

The next problem, one of the most important to the maintenance man, is the design of the battery racks or tables and the method of transferring the battery between the tractor and the charging racks.

Several types of racks, such as roller tables and angle-iron frame works, were tried at the Sparrows Point plant. A simple rack consisting of two 14 in. I-beams spaced to support the batteries and securely anchored to the floor was found to be most practical.

Fortunately, overhead cranes were available in the area where our largest batteries were to be charged. These cranes were arranged to be controlled from a mast suspended from the cranes. This mast was located in a position which made it possible for the battery room attendant to operate the crane and hook up the battery from the same standing position. The crane hook was equipped with a spreader to avoid crushing the batteries during movement.

A washing rack large enough to support one battery was provided. This rack was located where fresh running water and sewer facilities were available.

Fresh water from a source approved by battery manufacturers was provided for flushing and made accessible all along the charging racks. Automatic fillers that signal when the water level is at the proper height in the battery cell were installed. Flexible charging leads were conveniently arranged and identified as to charging panel origin.

The storage batteries used in the industrial truck fleet described in this paper are of the lead acid type; although a number of nickel alkaline batteries are used in various applications in other parts of the Sparrows Point plant.

Two methods of automatic charge control for lead type industrial truck batteries are available. One is known as the "modified constant potential method," and the other as the "two-rate method." The modified constant potential method in use in our plant has proved satisfactory.

Battery manufacturers agree that a bus voltage equalling 2.63 volts per cell is satisfactory for an eight hour charging period. This bus voltage must be kept constant either through the use of some type of voltage regulator, or by a generator designed for constant voltage under all load conditions.

The individual charging panels used with the modified constant potential method include a contactor or circuit breaker, an ampere-hour meter and a fixed resistance. This resistance in series with the battery limits

Presented before AISE Philadelphia District Section Meeting, April 3, 1948

both the starting and finishing rate of charge. As the charge progresses a gradual taper results, due to the increase in counter voltage of the battery.

Finishing rates are specified on all new batteries and should be closely adhered to, or at least not exceeded. Since the counter voltage of a battery decreases with age, an increase in finishing rates is a natural result. This is a condition difficult to overcome when charging batteries of various ages from the same source of voltage.

The two-rate method of charge employs two sections of series resistance and two contactors. One contactor changes the value of resistance in the charge circuit when the battery counter voltage has reached a certain value; the other opens the circuit when the charge is completed. It is obvious that with this type of control the finishing rate can be adjusted without changing the start.

Two methods of automatically terminating the charge of batteries are available. One employs the ampere-hour meter, and the other the voltage-relay timer. The ampere-hour meter is manually set from a chart supplied by the battery manufacturer. This chart indicates the setting of the meter for various stages of discharge as indicated by hydrometer readings of a pilot cell. The voltage-relay timer operates on the principle that the voltage relay will function at the gassing point of the battery, which is about 2.37 volts per cell. This relay starts the timer and in the event two-rate charging is used, it can be employed to set up the circuit for the finishing rate. The timer can be adjusted to suit local conditions.

Industrial truck batteries should be given an equalizing charge at regular intervals to restore all cells to a fully charged condition. The rate of this charge should be relatively low. The charge should be terminated when the specific gravity of the lowest cell has not changed over a two hour period.

Over flushing and frequent use of the hydrometer naturally results in the loss of some electrolyte. After an equalizing charge, if the specific gravity of some of the cells is lower than normal, it may be necessary to add acid. Sulphuric acid with a specific gravity of 1.300, used several times instead of water to bring the electrolyte to its proper level, will generally restore the faulty cell to normal. In event the decrease in gravity is considerable, examination of the faulty cells should be made for leaking jars or covers. Faulty cells should be removed from the battery, the electrolyte dumped and replaced with electrolyte of the correct specific gravity.

A common fault with most battery maintenance personnel is the tendency to reset the ampere-hour meter if no appreciable change in specific gravity is noticed during the first two hours of charge. There is a natural lag of change during the early part of the charge, and the resetting of the meter results in overcharge which definitely shortens the life of the battery. Batteries should always be flushed at the end of the charge since the electrolyte increases in volume during the charging period.

If a jar is damaged enough to allow the electrolyte to escape in considerable quantity, the cell should be removed electrically by disconnecting and bridging it to complete the battery circuit.

Some care must be taken when working on storage batteries to eliminate the danger of explosions due to the discharge of gases during the charging period. These gases, hydrogen and oxygen, can be removed by blowing out the cells with air. A wet cloth covering the entire battery while repairs are being made is also a wise precaution. Modern plant safety programs call for the use of goggles when making repairs of this nature.

Flexible cell connectors are generally removed by burning or melting the flexible connector head loose, using either the carbon burner or a small tipped acetylene torch. When using a carbon burner, use three cells of the battery, connecting the carbon tip to the negative end of the cells, and the connector, to be removed, to the positive end of the six volt circuit. When the head has been melted loose it can be easily removed with a pair of combination pliers.

To replace the connector, thoroughly clean both the connector and cell post. Tap the connector into position, have your carbon tip connected as before and burn or weld the joint.

The average battery repairman soon becomes proficient in this simple operation, and if made to understand the importance of good electrical connections, no trouble with high resistance joints should be experienced.

A detailed description of the method used in removing a cell from a tray or the sealing of a cover to a cell is unnecessary in this paper. The tools are simple, and information of this nature is available from all battery manufacturers. It is important that sealing compound be maintained to prevent cell leakage of electrolyte, and damage to the trays.

Overheating and failure of individual cells to take a charge can generally be attributed to faulty separation. Modern industrial truck batteries are generally separated with hard rubber, and short-circuited cells caused by broken or burned separators are not of frequent occurrence. Reseparating should be done by trained mechanics whenever possible, particularly in cells using glass retaining mats or envelopes in addition to the separators.

Dirty and wet battery tops will result in high current leakage and all the faults incident to corrosion. Baking soda scattered over the top of the battery is a good neutralizing agent. The residue should then be flushed off with a fresh water hose and the battery top dried by the use of low pressure air.

A complete and accurate record should be kept of the performance of each battery. This record should include the number of cycles per day, the number of hours the battery remains in service, time necessary to recharge, and the specific gravity of the pilot cell before and after the charge period. Frequent checking of these records will indicate those batteries needing special attention and which type of battery is best adapted to your service.

Industrial truck storage batteries are sold with a definite operating-life expectancy. This operating life is figured in cycles, that is, so many complete charge and discharge periods. Careful attention to charging voltages, finishing rates, cell temperatures and general cleanliness will tend to increase the number of full cycles your battery will give you.

Roll Turning with

. . . . the advent of new machine tools and continued progress in tool engineering and application combine to establish improved and more economical methods of machining rolls . . . .

▲ NOTABLE savings in time and cost required for the manufacture and servicing of mill rolls are now being made through the application of cemented carbide tools developed for this specific service during the past two years.

Two methods of machining straight body chilled cast iron rolls to size have been in common use—grinding on very hard rolls (75-90 scleroscope) and turning with high speed steel tools on softer rolls (60-75 scleroscope).

Rough grinding is a costly operation. It is very slow, and production has often been limited by inadequate facilities; the hourly machine charges are high, and the consumption of grinding wheels is very great. Machining with high speed steel tools also has its production limits because of slow speed cutting and the frequent tool changes required.

Figure 1 — Roll finishing tools are commonly used for plunge cutting and hand feeding.

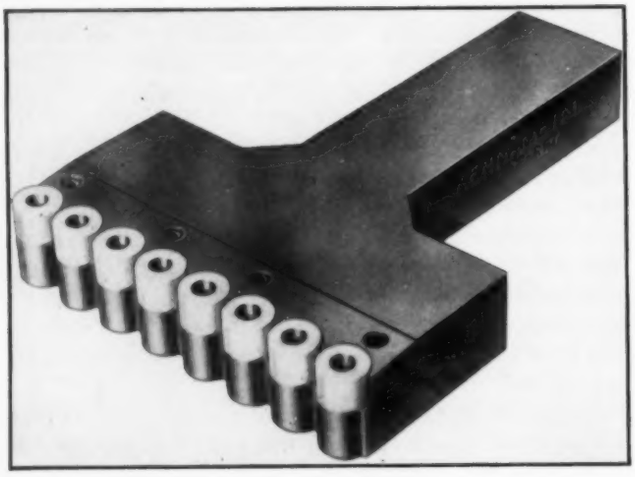


Figure 2 — This roll roughing tool was developed because the most severe duty on such a tool occurs on the initial plunge into the surface.

That carbide tools speed up metal cutting operations has been widely recognized by industry, but their use in roll shops had been restricted for several reasons.

1. High speed lathes, traditionally considered necessary for the successful use of carbide tools, were not available in roll shops.
2. Carbides having sufficient strength for this rigorous duty were not available.
3. The customary method of fastening the cutting tip to a steel shank (by brazing) proved unsuitable. Cemented carbides have a coefficient of thermal expansion about one-half that of steel. In cooling from brazing temperature, the steel shrinks twice as much as the carbide, and subjects the top surface of the tip to tensional strains. This is tolerable on small tools, but is prohibitive on the large broad nose tools customarily used for plunge cut roll turning. Consequently, other means of fastening had to be devised.

Within the past few years, knowledge of the requirements and possibilities for metal cutting in this specific industry have increased. Marked advancement has been made in the manufacture of cemented carbides, and in tool design.

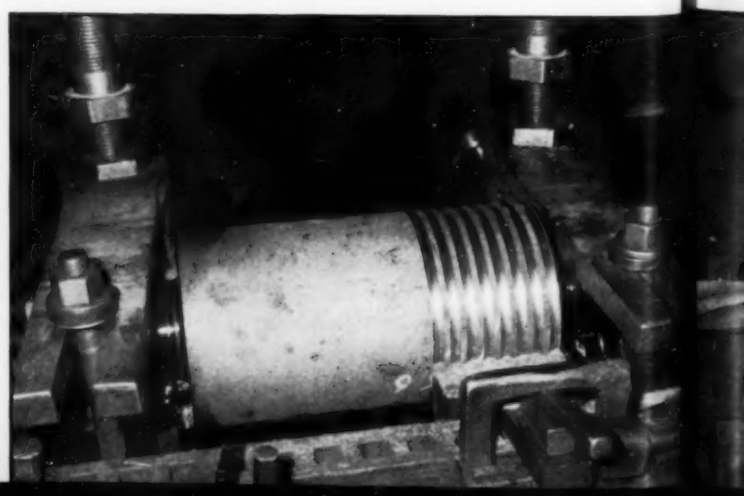
The relatively slow speeds, and hand feed of the prevalent type of piano rest roll lathe, together with the rather common practice of adjusting the position of a tool while cutting, have not proved as great deterents to the use of carbides as was formerly supposed.

An improved cast iron cutting grade of carbide is now available that combines high hardness with great strength and rigidity (a hardness of 92.2 Rockwell A, a transverse rupture strength of 260,000 psi, and a Young's modulus of elasticity of 94,300,000 psi).

In cooperation with leading roll manufacturers the writer's company has developed tools for this service, which have the carbide element mechanically held to the steel shank. The thermal strain-free assembly thus effected compensates for the difference in expansion rates of carbide and steel, and permits full utilization of the inherent high strength of the carbide.

One form of tool, applicable to the common type of

Figure 3 — The first roughing cut is being taken on a section of a cast-iron roll, 11¾ in. in diameter by 21¾ in. face, 65 scleroscope at surface speed of 12 fpm. The tool used here is similar to that shown in Figure 2 and is 8 in. wide.



Carbide Tools

By F. R. DINGER

Kennametal, Inc.

Latrobe, Pennsylvania

roll lathe requiring plunge cutting and hand feed, is shown in Figure 1. A flat blade of solid carbide is securely held in position on an accurate surface of the shank by combination of a clamp and serrated advanceable back up plate—all of hardened steel. The four cutting edges are used in succession before any sharpening is required. Then the blade can be reground time and again (long sides only) and advanced to cutting position.

Realization of the fact that the most severe duty imposed on a tool is during the initial plunge into the surface, whether on a new roll or on a redressing job, led to the development of another type of tool, shown in Figure 2, which has a set of carbide cylinders, or "buttons" (indexable and replaceable) instead of a continuous blade.

This tool cuts through scale quicker and more uniformly, requires less pressure, permits faster speeds and feeds, trues up a roll quicker than a broad nose tool, and leaves less stock for the finishing tool.

The first plunge cut turns a series of circular grooves with rough humps between. The tool is then moved over and a second cut made to remove these humps, leaving a scalloped surface that is readily cut to finish size with a broad nose tool. When the cylinders become dull, they can be turned to successively new cutting positions. Several cuts can thus be taken before sharpening is required. Regrinding is simplified, as only the tops of the cylinders need to be smoothed off. Any damaged cylinder can be quickly and economically replaced by one in good condition.

Both of these tools, the blade type and "button" type, have proved entirely satisfactory in the conventional roll lathe, for turning cast iron rolls in the hardness range of 75-90 scleroscope. Either style will cut through "chill balls," and hard or burned spots. In most cases they have offered the only means of machining rolls in this condition, save by the long process of grinding. It is now common practice to use the "button" type for roughing and the blade type for finishing.

As a rule, straight body rolls only have been machined with these tools, although in many cases the insert has been positioned differently or specially shaped to produce required contours on the roll surface.

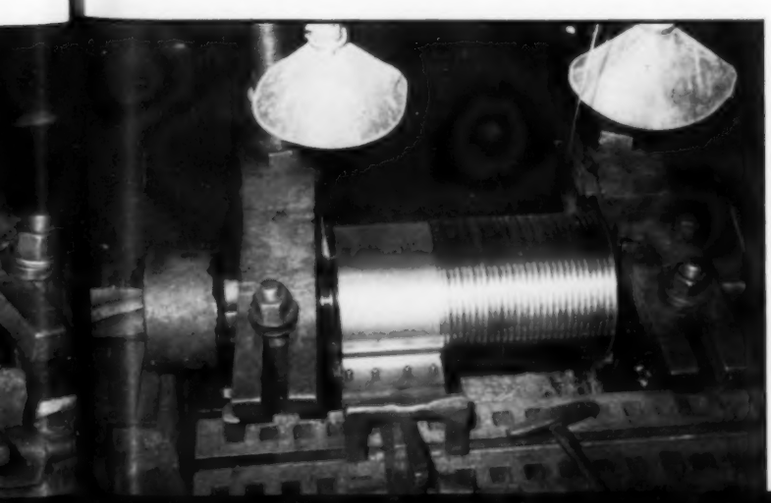


Figure 4 — A portion of the roll face roughing cutter, which is illustrated in Figure 3, is being finish turned to size. Inasmuch as a roughing tool turns the roll in a series of grooves, the roughing tool is moved over half the width of one groove, resulting in the surface shown in the right hand side of this photograph. The finishing cut then cuts down the high spots leaving the smooth finish shown on the left hand side of the figure.

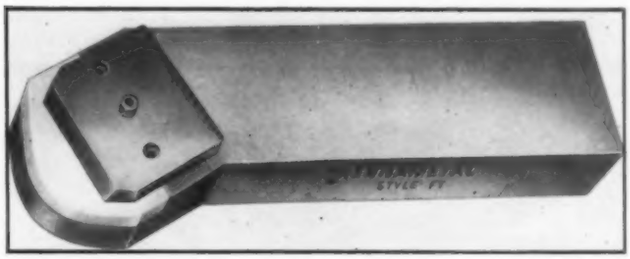


Figure 5 — A turning tool was developed for machining roll fillets. It has an advanceable carbide blade.

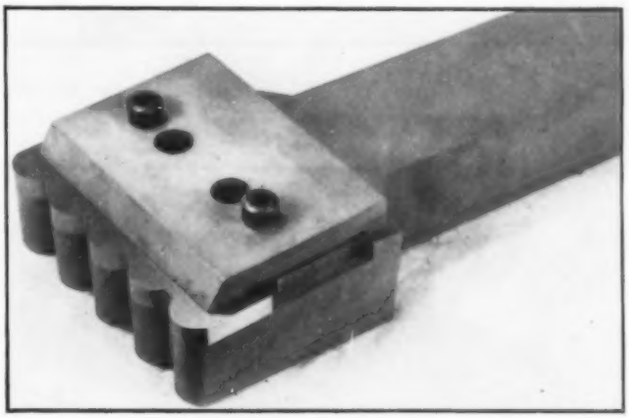


Figure 6 — This roll forming tool with an advanceable carbide blade was developed for contoured working surfaces.

By using the tools as described, it has been possible to turn hard rolls (75-90 scleroscope in one-half the time required for grinding and to turn softer rolls (60-75 scleroscope) in one-half the time required with high speed steel tools. Speeds ranging from 6 to 18 surface feet per minute can be used with carbide tools as compared to 1½ to 4 with high speed steel tools. Higher speeds in conjunction with more consistent and longer tool life account for the marked saving in time.

The best results have been attained on lathes that support a roll on its necks rather than between centers, because of greater rigidity during cutting, although definite savings in machining time are realized on both types of lathes.

The sequence of roughing and finishing operations are shown in Figures 3 and 4, inclusive.

Another mechanically held tool, Figure 5, has been developed for machining the fillets on rolls. It is available in a range of sizes with advanceable carbide blades having radii for the most common sizes of fillets.

An adaptation of the blade type tool for turning rolls having a contoured working surface has been used successfully. It is shown in Figure 6. The carbide blade is ground to a form that will produce the required shape by plunge cutting. It has four cutting edges that are sharpened simply by surface grinding the top and bottom. Mounting at 5 degrees negative back rake provides desired cutting angles and clearances and permits use in four positions. Original contours are not disturbed. This type of tool should be of interest to manufacturers of rod, or other shapes, who use rolls on which a repetitive pattern must be maintained.

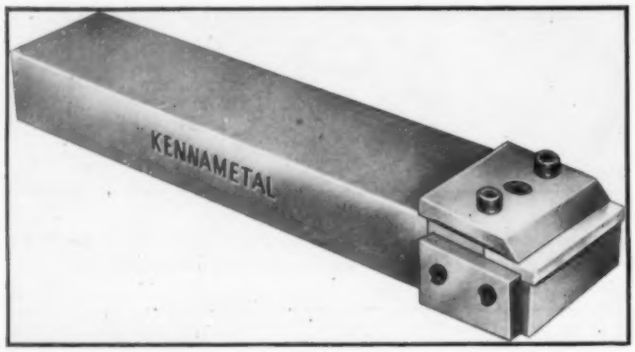


Figure 7 — A clamp-on tool was developed for turning rolls on screw feed lathes.

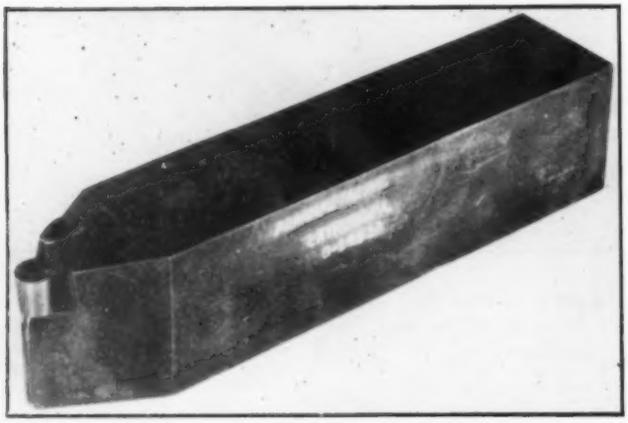


Figure 8 — This is one type of mechanically-held tool used in contour turning. A harder grade of carbide is used for finishing then is used for the roughing cuts.

For shops using engine lathes to turn straight body rolls, clamped-on tools have also been developed. One type is shown in Figure 7. The tool is set in the tool block to provide a lead angle much greater than that on conventional turning tools, which permits the load to be distributed over a broader cutting edge when heavy feeds are used. The chip is wide and very thin. Speeds used range from 30 to 80 surface fpm, and feeds from 0.030 to 0.045 in. per revolution. Several roll manufacturers have found that with this method a roll can be finished in much less time than by plunge cutting on the more common roll lathe.

Shaped rolls are customarily machined on the conventional roll lathe by plunge cutting and blending with a series of high speed steel tools at low speeds—4 to 6 surface fpm.

Figure 9 — Contour turning a roll at a surface speed of 55 fpm. The longitudinal feed is 0.035 in., and the transverse feed is 0.018 in.

A new and revolutionary method is now being used in some shops with remarkable saving in time. On engine lathes having suitable attachment, continuous turning of the contours is accomplished with one single point tool which automatically follows the template form through electro-magnetic control of the carriage and tool slide. Reports indicate that rolls can be machined in $\frac{1}{4}$ to $\frac{1}{8}$ the time formerly required. Less skill is involved than with the "cut and try" method, tool inventory is greatly reduced, and rolls are more accurately duplicated or mated.

Before contouring, the rolls are rough turned to within $\frac{1}{32}$ in. of the nominal diameter with a clamped on tool set at a greater than normal lead angle, and the tip ground to a 5 degree negative back rake on the side cutting edge. Speeds up to 100 surface fpm are used with about $\frac{1}{32}$ in. feed.

One type of contouring tool used is shown in Figure 8. The cutting element is a carbide "button" clamped to the shank and centered on a steel pin. It is indexable to successive cutting positions, without adjusting the shank, when the contacting edge becomes dull. Speeds range up to 100 surface fpm, depending upon the nature

Figure 10 — Knurling roll is shown here roughing up a work roll.

TABLE I

Operating Recommendations

Type of cutting	60-75 scleroscope						75-90 scleroscope					
	Speed, fpm		Depth of cut, in.		Feed		Speed, fpm		Depth of cut, in.		Feed	
	Rgh	Fin	Rgh	Fin	Rgh	Fin	Rgh	Fin	Rgh	Fin	Rgh	Fin
Plunge*	12	18	...	...	Hand feed	Hand feed	6	10	...	...	Hand feed	Hand feed
Screw feed	60	80	3/8 max	0.050	0.062	0.030	30	45	1/4 max	0.050	0.045	0.030
Contour	100	100	3/8–1/2	1/32	0.030	0.020	...	...	...	...	...	...

*Speeds given are for turning on necks in housing lathe.

of the roll and its hardness. Longitudinal feeds range from 0.020 to 0.030 in., and transverse feeds from 0.015 to 0.020 in. A typical contouring operation is shown in Figure 9.

At the present time, only the softer rolls (60-75 scleroscope) are being machined by this method.

Knurling of steel rolls, which is no more than a "roughing up" operation has been quite a problem for years. Here, also, carbide is being used successfully. The knurling roll shown in Figure 10 has knurled over 500 rolls without having to be reground. Heretofore, one to five high speed steel knurls were required to "rough up" one roll of the same size.

Continuing progress is now being made in the roll machining field after lying almost dormant for many years. Great forward advancement should be made in the future, inasmuch as the companies that are required to machine rolls are now aware of the possibilities of using carbide in this type of work, and machine builders are beginning to realize the demand for new machine tools and new methods of machining. It seems, therefore, that the desire of roll suppliers and users to produce rolls faster, the advent of new machine tools, and the continued progress in tool engineering and application will combine to create decidedly improved methods of machining rolls. Not only will reduction in cost be realized, but a better and harder product will be made available to the metals rolling field.

Republic's New 48 in. Mill

AT YOUNGSTOWN, OHIO

By T. J. Ess

▲ AN ingenious combination of new facilities with existing equipment is to be found in the 48 in. strip mill at Republic Steel Corporation in Youngstown, Ohio. Completed about a year ago, the mill was made by adding three four-high finishing stands and coiling equipment to an existing 84 in. plate mill.

The mill was installed in the existing plate mill building, which is 400 ft long x by 53 ft wide and is served by a 30/5-ton crane. Three new buildings were constructed, including a slab storage 145 ft x 39 ft, served by one 15-ton crane, a coil storage 120 ft x 56 ft, served by one 15-ton crane, and a motor room 200 ft x 42 ft-8 in., served by one 25-ton crane. A previously existing skelp storage, 175 ft x 103 ft, containing one 30-ton crane, completes the department.

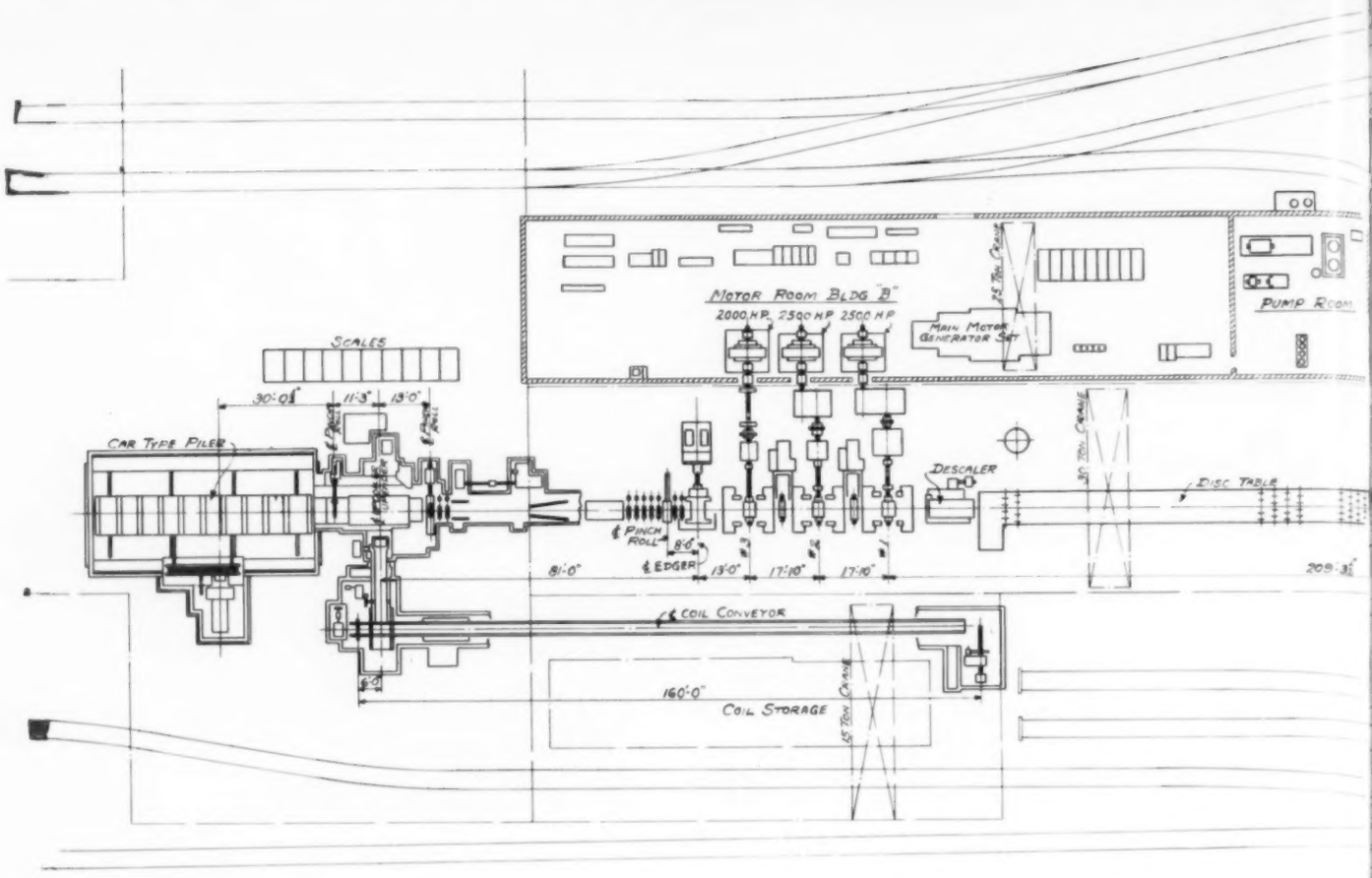
The plate mill, which forms the roughing end of the strip mill, is a three-high 22 in. and 32 in. x 84 in. universal stand driven direct by a 3330 hp, 500 volt, double armature, d-c motor. The motor operates under adjustable voltage control at 94-160 rpm, power being supplied by a single 2500 kw, 500 volt, d-c generator driven by a 4000 hp, 6600 volt, synchronous motor.

Rolls in the roughing stand run in composition roll neck bearings, and the screwdown is driven by one 100 hp, d-c motor.

Vertical edging rolls are located on the entry side of the mill, and are driven through gearing from the main roll drive.

Tilting tables on both sides of the mill manipulate the slabs between passes.

Heating facilities for this mill consist of three old continuous furnaces 40 ft long x 14 ft wide, each rated at 25 tons per hr, and one new continuous, triple-fired fur-



nace 78 ft long x 18½ ft wide, rated at 75 tons per hr. All of the furnaces burn coke oven gas, natural gas or fuel oil. Slabs are placed on the furnace charging tables by magnet and overhead crane, and are moved through the furnaces by mechanical pushers.

The finishing train, located 209 ft from the rougher, consists of three 48 in. four-high stands, spaced on 17 ft-10 in. centers. Work rolls in the first stand are 18 in. in diameter, and in the second and third stands, 16½ in. in diameter. All back-up rolls are 38 in. in diameter. Oil-flooded bearings are applied on back-up roll necks, with roller bearings on the work rolls. Two 35 hp motors operate the screwdown on each stand.

The three finishing stands are individually driven by 600 volt, d-c motors each, respectively, 2500; 2500 and 2000 hp, operating under adjustable voltage control. Speeds and gear ratios of these stands are as follows:

Motor rpm	Gear ratio	Roll rpm	Strip speed, fpm
225-450	3.82	59-118	278-556
225-450	2.00	112.5-225	486-972
150-375	Direct	150-375	648-1620

Roller bearings are used on all gear sets and pinion stands. Circulating oil systems provide lubrication for the back-up roll neck bearings on the finishing train, and for its pinions and gear reduction sets.

Immediately ahead of the finishing train is an up-cut shear with capacity to cut hot material up to one in. thick x 42 in. wide. This unit is used to crop the front end of the breakdowns, and is followed by a hydraulic descaling cabinet containing sprays above and below the strip. This cabinet, in conjunction with top and bottom sprays on the entry side of the roughing unit, effectively removes furnace and mill scale from the strip. Water for the sprays is supplied by a 1200 gpm, 1200 psi pump.

A rotary flying shear is located 13 ft beyond the exit of the finishing train. This unit is designed to cut material up to ½ in. thick and 42 in. wide into lengths up to 54 ft long. From the shear, the rolled product passes through a cabinet containing 375 psi cooling sprays, and out over the runout table. Just 81 ft beyond the flying shear is a single up-coiler, with a collapsing mandrel 27 in. in diameter x 48 in. long. Eight wrapper rolls, 8 in. in diameter x 54 in. long, are arranged in pairs on hinged arms around the mandrel. Coils of 27 in. inside diameter, up to 43 in. outside diameter and in widths 14-42 in., can be formed of material up to 3/16 in. thick.

As coils are removed from the coiler, they are moved to a chain type cooling conveyor 160 ft long in the adjacent coil storage building.

Just beyond the coiler is a car type piler that will handle two piles of cut material up to 54 ft long.

The new motor room houses the three finishing drives, together with motor-generator sets, switchgear and controls. The main motor-generator set, which consists of two 2500 kw and one 500 kw, 600 volt, d-c generator, driven by a 7800 hp, 6600 volt synchronous motor supplies power to the finishing stands and flying shear drive. Power for coiler and looper motors comes from a set composed of one 100-kw, one 15-kw and one 10-kw generator, and a 200 hp, 440 volt squirrel cage

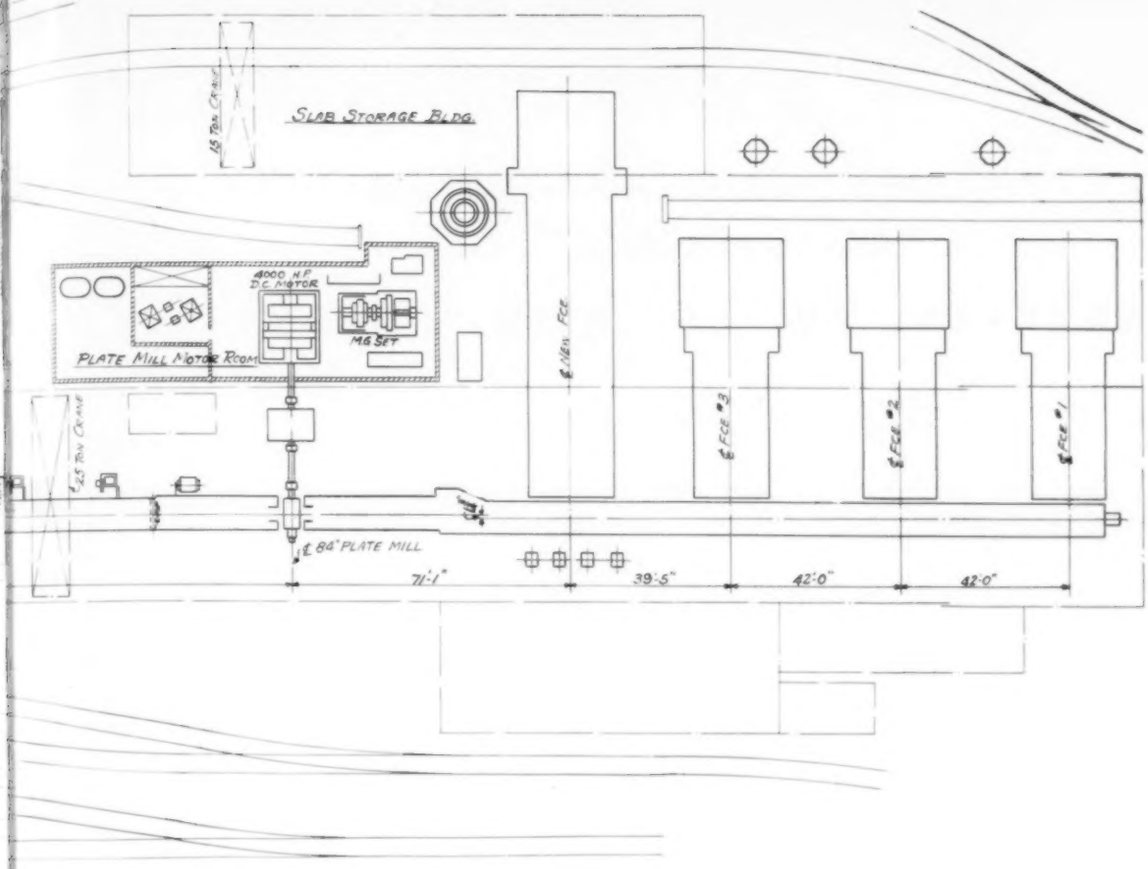


Figure 1 — This mill was made up of an existing plate mill shown on the right to which was added the three finishing stands and coiling equipment shown to the left of the layout sheet.

motor. Another set, composed of two 100 kw, 250 volt, d-c generator and a 300 hp, 440 volt squirrel cage motor, provides power for the runout table motors. The necessary exciter sets are also located here.

This mill, in a space of approximately 625 x 165 ft, provides rolling capacity for 60,000 tons per month of skelp and strip. Slabs 13½-42 in. wide, 3¾-6 in. thick, and approximately 12 ft long are rolled into gages of 0.072-0.50 in. The slab is reduced in the roughing stand to thicknesses of 5/16 to one inch, while reductions in the three finihsing stands range, respectively, 20-50 per cent, 10-40 per cent, and 10-25 per cent. Typical reduction schedules are as follows:

Figure 2 — Shown here is the delivery end of the mill which consists of three 48 in., four-high stands.

	Thickness, in.
Breakdown	0.984 — 0.640 — 0.312
1st pass	0.752 — 0.434 — 0.156
2nd pass	0.588 — 0.312 — 0.094
3rd pass	0.500 — 0.250 — 0.072

Finishing speeds usually range from 650 fpm on ½ in. material up to 1210 fpm on 0.072 in. gage.

This expansion provides greater integration of Republic's Youngstown plant by improving the balance between ingot production and finishing capacity, but does not make greater tonnages of sheet and strip available to the trade. The major items rolled on the mill are skelp for the three electric weld tube mills at Youngstown and strip for further processing into tin plate at the Niles plant of Republic's Warren district.

Before the completion of this project, slabs from Youngstown were shipped to Warren to be hot rolled into strip for tin plate, and the coils were then trucked to Niles for cold reduction and tinning. Now the coils are hot rolled at Youngstown and shipped directly to Niles. Thus, the overload on the Warren hot strip mill has been relieved.

1948 ANNUAL CONVENTION AND IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 28, 29, 30, AND OCTOBER 1

Official Program

Tuesday, September 28

IRON AND STEEL EXPOSITION — 10:00 a.m.-10:00 p.m. — Arena and Exhibit Hall

9:00 a.m. — REGISTRATION — Main Lobby

9:00 a.m. — LADIES' REGISTRATION AND HEADQUARTERS — Parlor L-M, Hotel Statler

9:15 a.m. — BUSINESS MEETING — Ball Room

Conducted by President A. J. Fisher

9:30 a.m. — ELECTRICAL SESSION — Ball Room

Chairmen: I. N. TULL
Republic Steel Corporation
J. D. O'ROARK
Weirton Steel Company

"Electric Cables for the Steel Industry," by E. W. Davis, Simplex Wire and Cable Company

"Some Results of Mercury Arc Rectifier Operations in Carnegie-Illinois Steel Corporation Plants," by Frank W. Cramer, Carnegie-Illinois Steel Corporation

"Air Conditioning of Crane Cabs," by R. D. Darrah, Dravo Corporation

12:00 M. — LADIES' LUNCHEON

(Meet at Ladies' Headquarters)

ALL EVENTS EXCEPT SOCIAL FUNCTIONS WILL BE HELD AT CLEVELAND PUBLIC AUDITORIUM

2:00 p.m. — OPERATING PRACTICE SESSION — Club Room B

Chairmen: J. L. TATMAN
Wheeling Steel Corporation
WILLIAM H. COLLISON
Great Lakes Steel Corporation

"Hot Blast Stoves for Modern Blast Furnaces," by R. L. Clark, John Mohr & Sons

"Blast Furnace Practice at Fontana," by C. H. Lenhart, Kaiser Company, Inc.

"Special Cars in Steel Plants," by E. W. Schellentrager, The Atlas Car & Manufacturing Company

2:00 p.m. — STANDARDIZATION SESSION — Ball Room

Chairmen: F. W. CRAMER
Carnegie-Illinois Steel Corporation
LEONARD LARSON
Republic Steel Corporation

"Report of Standardization Committee — 1948," by Frank W. Cramer, Chairman AISE Standardization Committee

"Analytical and Experimental Studies of Ladle Hooks," by Carl W. Muhlenbruch, Northwestern Technological Institute

"Stresses in Hot-Metal Ladles," by K. E. Knudsen, W. H. Munse and B. G. Johnston, Fritz Engineering Laboratory, Lehigh University

10:00 p.m. — EXHIBITORS' DANCE — Euclid Ball Room, Hotel Statler

Wednesday, September 29

IRON AND STEEL EXPOSITION — 10:00 a.m.-10:00 p.m.

9:00 a.m. — COMBUSTION SESSION — Ball Room

Chairmen: B. B. BARGMAN
Carnegie-Illinois Steel Corporation
E. C. HITE
Timken Roller Bearing Company

"Steel Temperature Measurement and Control of Reheating Furnaces," by Fred S. Bloom, Bloom Engineering Company, Inc.

"Maintenance of Hearths in Heating Furnaces and Soaking Pits," by Charles N. Jewart, Bethlehem Steel Company

"Effect of Oxygen on Refractories in the Basic Open Hearth," by R. S. Moore, Harbison-Walker Refractories Company

11:15 a.m. — LADIES' LUNCHEON

Buses will leave 12th Street entrance of Hotel Statler for The Country Club

Wednesday (Continued)

2:00 p.m. — MECHANICAL SESSION — Club Room B

Chairmen: F. S. ECKHARDT
Bethlehem Steel Company
P. L. WALTER
Republic Steel Corporation

"Mechanical Insert Repairs in the Steel Industry," by R. L. Rectenwald, Metalock Corporation of Pennsylvania
"Water Works Maintenance," by George H. Dann, Philadelphia Suburban Water Company
"What the Machine Tool Industry Wants from the Steel Industry," by Tell Berna, National Machine Tool Builders' Association

2:00 p.m. — ELECTRICAL SESSION — Ball Room

Chairmen: V. E. SCHLOSSBERG
Inland Steel Company
D. C. NELSON
Jones and Laughlin Steel Corporation

"Electrical Equipment for Rolling Cold Strip at 70 Mph," by William E. Miller, Steel Mill Division, General Electric Company
"Review of D-c Drives on Runout Tables and Coilers," by I. N. Tull, Republic Steel Corporation
"Improved Flying Shear Drive," by J. Raymond Erbe, Industry Engineering Department, Westinghouse Electric Corporation

6:00 p.m. — OLD TIMERS' DINNER — Euclid Ball Room, Hotel Statler

Thursday, September 30

IRON AND STEEL EXPOSITION — 10:00 a.m.-5:30 p.m.

9:00 a.m. — ELECTRICAL SESSION — Ball Room

Chairmen: R. W. GRAHAM
Bethlehem Steel Company
A. D. HOWRY
Alan Wood Steel Company

"Magnetorque A-c Crane Control," by F. W. Wendelburg, and F. M. Blum, Harnischfeger Corporation
"A Network System for Dynamic Lowering Hoist Control," by D. L. Pettit, Square D Company
"Designing the Proper Equipment for Extracting Ingots from their Molds," by H. W. Ball, The Morgan Engineering Company

9:00 a.m. — COMBUSTION SESSION — Club Room B

Chairmen: H. S. HALL
Lukens Steel Company
C. E. DUFFY
Bethlehem Steel Company

"Training Instrument Mechanics at Sparrows Point," by F. R. Pullen, Bethlehem Steel Company
"Fuel Oil in the Steel Industry," by A. J. Fisher, Bethlehem Steel Company
"Liquefied Petroleum Gases for the Steel Industry," by Francis E. Drake, Pacific Gas Corporation

2:00 p.m. — LUBRICATION SESSION — Club Room B

Chairmen: D. N. EVANS
Inland Steel Company
R. A. BARTA
Republic Steel Corporation

"High Temperature Lubricants and Their Evaluation," by G. L. Sumner, Westinghouse Electric Corporation
"Centrifugal Clarification of Oil in Steel Plants," by Charles M. Ambler, The Sharples Corporation
"Modern Sealing Devices for the Steel Industry," by R. A. Kraus, Republic Steel Corporation

2:00 p.m. — ROLLING MILL SESSION — Ball Room

Chairmen: C. W. BARRETT
Republic Steel Corporation
J. N. IMEL
Jones and Laughlin Steel Corporation

"Analysis of Cold Mill Design," by Frank P. Dahlstrom, Arms-Franklin Corporation
"Beam and Channel Roll Design," by Ross E. Beynon, Carnegie-Illinois Steel Corporation
"Deformation in Rolling," by George S. Mican, Carnegie-Illinois Steel Corporation

7:30 p.m. — FORMAL DINNER-DANCE, Grand Ball Room, Hotel Statler

Speaker: J. E. Goble, President, National Tube Company

Friday, October 1

IRON AND STEEL EXPOSITION — 10:00 a.m.-4:00 p.m.

9:00 a.m. — MATERIAL HANDLING SESSION — Ball Room

Chairmen: H. W. NEBLETT
Inland Steel Company
A. G. ERICSON
Carnegie-Illinois Steel Corporation

"Coal Preparation for Steel Manufacturers," by N. L. Davis, Nelson L. Davis Company
Problems in Handling Heavy Coils — Symposium
Cranes — R. G. Birkin, Cleveland Crane & Engineering Company
Trucks — B. I. Ulinski, Automatic Transportation Company.
Conveyors — J. E. McBride, Palmer-Bee Company

2:00 p.m. — LUBRICATION SESSION — Club Room B

Chairmen: C. E. PRITCHARD
Republic Steel Corporation
A. E. CICHELLI
Bethlehem Steel Company

"Developments in Sleeve Bearings," by A. B. Willi, Jr., Federal Mogul Corporation
"Preventive Maintenance of Electric Oils," by C. J. Egger, Bowser, Inc.
"The Use of Rust Preventives in the Maintenance of Steel Structures," by Joseph G. Surchek, Dearborn Chemical Company

2:00 p.m. — OPERATING PRACTICE SESSION — Ball Room

Chairmen: C. L. McGRANAHAN
Jones and Laughlin Steel Corporation
J. S. STANIER
Youngstown Sheet and Tube Company

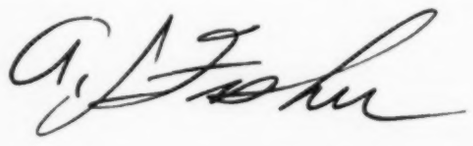
"Developments in Butt Weld Tube Mills," by W. Rodder, Aetna-Standard Engineering Company
"Strip Welding," by F. R. Thompson and F. J. Waldschutz, Mesta Machine Company
"Mandrel Type Hot Strip Coiler," by G. E. Farrington, E. W. Bliss Company

An Invitation to All Steel Industry Personnel

The 1948 Annual Convention and Iron and Steel Exposition of the Association of Iron and Steel Engineers again presents to the men of the industry a fine opportunity to view and discuss modern developments and improvements in engineering and operating practices.

Bigger in scope than ever before in the Association's history, these activities will offer an overall perspective of post-war developments, at a time when productive efficiency is again of major significance.

On behalf of the exhibitors, and of the officers and staff of the Association, I extend to all personnel of the iron and steel and allied industries a cordial invitation to attend the exposition and technical sessions. We know that participation in these activities will prove profitable.



President, AISE

AUTHORS AND CHAIRMEN

1948 AISE CONVENTION

CHARLES M. AMBLER

HARVEY W. BALL

B. B. BARGMAN

C. W. BARRETT

R. A. BARTA

TELL BERNA

ROSS E. BEYNON

R. G. BIRKIN

FRED S. BLOOM

F. M. BLUM

ANDREW E. CICHELLI

AUTHORS AND CHAIRMEN

WILLIAM H. COLLISON

FRANK CRAMER

FRANK P. DAHLSTROM

GEORGE H. DANN

R. D. DARRAH

E. W. DAVIS

FRANCIS E. DRAKE

C. E. DUFFY

F. S. ECKHARDT

C. J. EGGER

J. RAYMOND ERBE

1948 AISE ANNUAL CONVENTION

A. G. ERICSON

D. N. EVANS

A. J. FISHER

R. W. GRAHAM

H. S. HALL

E. C. HITE

A. D. HOWRY

J. N. IMEL

C. N. JEWART

BRUCE G. JOHNSTON

KNUD-ENDRE KNUDSEN

ROBERT A. KRAUS

AUTHORS AND CHAIRMEN

LEONARD LARSON

C. H. LENHART

C. L. McGRANAHAN

GEORGE S. MICAN

W. E. MILLER

R. S. MOORE

CARL W. MUHLENBR

WILLIAM H. MUNSE

H. W. NEBLETT

D. C. NELSON

1948 AISE ANNUAL CONVENTION

J. D. O'ROARK

D. L. PETTIT

C. E. PRITCHARD

F. R. PULLEN

R. L. RECTENWALD

W. RODDER

E. W. SCHELLENTRAGER

V. E. SCHLOSSBERG

J. S. STANIER

G. L. SUMNER

AUTHORS AND CHAIRMEN

J. G. SURCHEK

J. L. TATMAN

F. R. THOMPSON

I. N. TULL

B. I. ULINSKI

F. WALDSCHUTZ

P. L. WALTER

FRANK WENDELBURG

ALBERT WILLI, JR.

ABSTRACTS OF PAPERS

To be presented at ANNUAL AISE CONVENTION Public Auditorium, Cleveland, Ohio, September 28, 29, 30 and October 1, 1948

Some Results of Mercury Arc Rectifier Operations in Carnegie-Illinois Steel Corporation Plants

By FRANK W. CRAMER

Carnegie-Illinois Steel Corporation

▲ THE use of mercury arc rectifiers to supply the direct current power for auxiliary drives in our steel mills has increased rapidly during the past ten years. This follows the general trend in conversion equipment and at the present time the aggregate capacity of mercury arc rectifiers installed in the United States and Canada is about 5½ million kilowatts.

Since 1940, the Carnegie-Illinois Steel Corporation has installed 20 units of 250 volt d-c rectifiers and have on order two 1000-kw units and two 500-kw units. These are in addition to the two electronic frequency changers, one now being increased to 16,000-kw capacity and the second of 20,000-kw capacity.

Other than during the development period and starting up time, there have been few operating troubles with these units. On 250 volts d-c systems arc backs are practically unknown.

This type of equipment lends itself to installations in unusual places, does not need extensive foundations, air conditioning and the daily maintenance required by rotating equipment. The overall monthly efficiency is higher and they are well adapted for high short time peaks.

The Carnegie-Illinois Steel Corporation has been one of the pioneers in the application of electronic frequency changers. In simple language, these are two sets of mercury arc rectifiers arranged so that one set receives power at one frequency, say 60 cycles, converting this to direct current which is fed into the second set and converted to another frequency usually 25 cycles. These units will work in either direction. Since these units have a d-c tie, variations in frequency on either system do not necessarily affect the other. They are static machines, have an overall efficiency of about 94 per cent and can be supplied with many schemes for automatic control.

One disadvantage of this type of equipment is that a reactive power supply to be available on both systems. This limits its use to interconnecting two generating systems, although it is possible to use it on stub end feed if some means of supplying reactive power can be found.

In conclusion, the use of mercury arc rectifiers as a source of d-c power will continue to expand in steel mill operations. They are dependable tools with low maintenance, high availability and better efficiencies than can be obtained in rotating equipment. They are not used for power factor correction; which advantage can be obtained from the synchronous motor drives.

Carnegie-Illinois Steel Corporation has been well satisfied with the performance of this type of conversion equipment and at some future date expect to use it as a d-c power supply to certain types of large d-c main roll drives.

Electrical Cables for the Steel Industry

By E. W. DAVIS

Simplex Wire and Cable Company

▲ PROBABLY there is no industry wherein electric wires and cables are subjected to more hazards which limit service life than the steel industry. Some of the hazards, such as overloads, excessive voltage drops, internal heating, etc., can be avoided by adequate engineering and constant maintenance, but other hazards are inherent to the industry and practically unavoidable. Some of the latter are vibration, exposure to water and oil, and exposure to external heat.

Overload capacity, voltage drop and internal heating are all a matter of cable design, and may be readily limited in new plants and controlled in older plants if careful consideration is given to all the known factors of the electric system involved. It is possible to make the effect of these hazards negligible.

How serious the "inherent hazards" may become depends not only on the cable design but also on the types of materials which are used in the cable manufacture. Lead is not recommended around a steel plant due to its short vibration life. Cable insulation should be of the "submarine type," which is electrically stable under constant or intermittent exposure to water. The cable coverings should be resistant to deterioration when exposed to oils. Both the insulation and the protective sheaths or jackets should be resistant to deterioration due to external heat.

The development of the synthetic rubbers, one of the most spectacular and valuable developments of the war years, has placed in the hands of the cable manufac-

turers materials which, when incorporated into the design of cables for the steel industry, will result in longer and more satisfactory service life than has been experienced in the past years.

Air Conditioning of Crane Cabs

By R. D. DARRAH
Dravo Corporation

▲ AIR conditioning of crane cabs differs from normal comfort air conditioning, in that unusually extreme conditions of heat, fumes and gases, and dust and dirt are encountered. These conditions which materially affect the efficiency and comfort of the crane operators must be recognized, and the means must be provided to reduce them to tolerable proportions. Extreme temperatures such as are found around soaking pits and other hot metal cranes must be reduced to approximately 80 to 85 F. This reduction in temperature can be achieved satisfactorily only through mechanical refrigeration. Fumes and gases such as sulphur dioxide, carbon monoxide, hydrogen fluoride, coal smoke and aldyhydes should be removed or decreased in concentration considerably below the allowable maximum. Activated carbon in canister form or in pan type form will absorb all of these gases with the exception of carbon monoxide.

Crane cab air conditioning through the particular movements of the crane does provide a dilution of the carbon monoxide concentration, but not elimination. Independent tests have proven that such dilution amounts to 70 to 80 per cent less than the concentration in the ambient air of the plant. In order to keep the cost and size of the refrigeration equipment at an economical level, it is of considerable importance that the crane cab itself be insulated so that the heat transmission through the floor and walls of the cab will be kept to a minimum. Where crane cabs are exposed to sources of large quantities of radiant heat such as is found over soaking pits and certain types of ladle cranes, it is advisable that a heat shield be installed below the floor of the cab. Such shields are quite effective in lowering the heat transmission through the cab floor. Where the glass area of windows in cabs is comparatively small, ordinary safety glass is quite satisfactory for this purpose. On the other hand, where large expansive areas of glass are desired, hermetically sealed, double glaze windows should be used.

For providing comfortable and efficient working conditions, the self-contained air conditioning units using air for condensing purposes have proven most satisfactory. A refrigerant with a comparatively low boiling point must be used in order that working pressures developed in such high temperatures will be considerably below the working limits of the various items of equipment. All equipment within the air conditioning unit should be compactly arranged, but also quite accessible for easy maintenance. Motors and electrical contactors should be supplied with a quantity of cool, clean air, free from the various gases, so that dust, dirt and corrosive fumes will not attack the working portions of these units. Furthermore, motors, installed in a cool air stream or forced ventilated with cool air will develop their fully rated horsepower and will not require special insulation.

When installing crane cab air conditioning equipment, it is highly advisable to place unit as close to the crane cab as possible so that long, heavily insulated ducts will not be required and a considerable amount of the cost of such installation can be eliminated.

Special Cars in Steel Plants

By E. W. SCHELLENTRAGER
The Atlas Car & Manufacturing Company

▲ THIS paper discusses improvements in protecting main knife edges of blast furnace scale cars which are expected to result in longer trouble-free performance. The latest cars are of 40 tons capacity. The paper also discusses briefly characteristic types of weight recording equipment. Bin filling cars are covered and a 65-ton capacity car is recommended. Largest car of this type in service is 150-tons capacity. All transfer cars should have electric heaters for winter operation. Newest transfer cars are hydraulically operated to give control of discharge gates. Diesel-electric self-powered transfer cars are briefly mentioned. Three different modern systems for handling strip on cars are described and include battery operated cars of 135-tons capacity. Emphasis is placed on the use of battery operated cars by a simplified type called "walk-along" for miscellaneous short haul service in steel mills. Mention is also made of highly specialized types of cars.

Blast Furnace Practice at Fontana

By C. H. LENHART
Kaiser Company, Inc.

▲ SINCE the "blow in" of the blast furnace at Fontana, on December 31, 1942, many stories regarding its operation, some true and some false, have been circulated throughout the iron and steel industry. The purpose of the paper is to acquaint as many people as possible with the true facts and to give them some idea of the problems involved in operating in the west.

The paper deals primarily with raw materials and their preparation, inasmuch as it is believed that the success so far obtained with the furnace can be, for the most part, attributed to raw materials. When speaking of western raw materials the word "raw" should be emphasized. The uniformity of material from day to day makes closely controlled beneficiation processes an absolute necessity if satisfactory results are to be expected in the blast furnace. The processes used at Fontana are merely basic types of beneficiation understood by practically every one in the industry, but their use has meant the difference between good and poor furnace operation.

The production of good metallurgical coke has always been a problem in the west. The information on coke plant operation contained in the paper indicates the steps taken to produce a coke acceptable to the blast furnace. A monthly average coke rate of 1,360 pounds per ton of iron sounds fantastic in these days of generally high coke rates; however, this figure was attained in July 1947. In fact, only a few times during the past

eighteen months has the coke rate been over 1,450 pounds per ton. The excessive use of scrap is not the explanation, inasmuch as no scrap is charged into the furnace.

The successful operation at Fontana has proved the value of raw material preparation and it is hoped that what has been learned will be of use to furnace operators throughout the industry.

Analytical and Experimental Studies of Ladle Hooks

By CARL W. MUHLENBRUCH
Northwestern Technological Institute

▲ AN analysis of ladle hook design procedures has been made and compared with observed field data. Riveted, together with riveted and welded, joints have been studied for both static and modified repeated loads.

Tests of compression type riveted joint specimens show that riveting may be combined with edge welding to provide a connection that has excellent resistance to the damaging effect caused by heating and cooling of the ladle hook. The effect of 300 repetitions of a load necessary to set up a shearing stress of 12,000 psi in the rivet shank shows that even a few load repetitions can cause considerable increase in slip. After 300 repetitions of load, A.S.T.M. A 141-39 rivets slipped 81 per cent more under static load but only 16 per cent when combined with welding. A.S.T.M. A 195-39 rivets showed 8.6 per cent more slip after repeated loading. Load-slip relationships are presented for hot-driven A 141-39 rivets, hot-driven A 195-39 rivets and cold-made cold-driven rivets alone or for rivets combined with edge welding. Elastic springback data and other evidence confirm the work of other investigators in showing that the strength of a hot-driven rivet is due to its initial grip. The importance of this action in ladle hook behavior is discussed.

Field tests of a hook fabricated with hot-driven rivets combined with edge welding and which had been in service for approximately six months prior to the date of testing showed a maximum temperature of approximately 1000 F on the hook shank above the lip of the ladle after an unkilled heat had been lifted for six minutes. The increase in length of the hot side of the hook caused transverse bending as a result of the load being applied to the plates on the cold side. Peak stresses were therefore higher than might normally be expected. Theoretical calculations and the observed data confirm this concept of the behavior of the hook.

Field tests of a new unwelded ladle hook which lifted a killed heat showed a maximum temperature of 250 F. Thermal stresses were not found to be important for this condition and transverse bending was not evident, indicating that the trunion load was uniformly applied to the hook. It is concluded that existing theoretical relationships such as the Winkler theory and analyses based on photoelastic test data are satisfactory for hook design.

It is shown that the application of a thin steel "insulating plate" to the hot side of the ladle hook will aid in reducing the transverse bending caused by lifting an unkilled heat.

Stresses in Hot Metal Ladles

By K. E. KNUDSEN, W. H. MUNSE and B. G. JOHNSTON
Fritz Engineering Laboratory, Lehigh University

▲ EXPERIMENTAL stress and deflection data are presented from structural tests of one-fifth scale models of three hot-metal ladles based on prototypes of approximately 150-tons net capacity. These models consisted of a round riveted ladle, an oval welded ladle, and a round welded ladle.

A semi-rational design procedure based on the information gained from these tests has been developed. The paper compares experimental and computed stress values, and a design example is worked out as a guide for practical design purpose.

Steel Temperature Measurement and Control

By FRED S. BLOOM
Bloom Engineering Company, Inc.

▲ THIS paper describes the progress made over a period of six years in applying the conventional open end sighting tubes to measure steel temperature in continuous billet heating furnaces. The paper describes types of installation such as the use of the vertical open end sighting tube and use of angle sighting tubes through the furnace side wall.

Numerous illustrations show the type of record obtained with various types of open end tube locations to indicate the error due to flame interference.

The results of using the measured steel temperature as a means of furnace fuel input control are discussed and flow charts are shown to describe the advantages that result from this method of control. The paper discusses location of the measuring eye with respect to furnace heating cycle and the difficulties encountered.

Effect of Oxygen on Refractories in the Basic Open Hearth

By R. S. MOORE
Harbison-Walker Refractories Company

▲ THE use of oxygen in basic open hearth furnaces has introduced some altogether new factors affecting the service life of the refractories in the roofs, the frontwalls and backwalls, and the port ends. As experience with this relatively new tool accumulates, the refractories manufacturer is studying causes and effects toward meeting these requirements.

The paper discusses reported effects upon refractory life from the introduction of oxygen into the slag or metal bath, and the introduction of oxygen at or in close proximity to the burner.

Paralleling the developments with oxygen experimentation in the basic open hearth are developments in the laboratories and plants of the refractories manufacturer in the field of silica brick with super duty brick

affording greater refractoriness than hitherto obtainable and in the field of basic brick designed to meet highly specialized applications. In the latter field design plays an important part and developments along this line are also discussed.

Maintenance of Hearths in Heating Furnaces and Soaking Pits

By CHARLES N. JEWART
Bethlehem Steel Company

▲ REFRACTORY problems encountered in maintaining bottoms in various types of reheating furnaces and soaking pits typical of a steel plant are discussed. The types of furnaces are: batch type regenerative, single, double and triple fired continuous with recuperators. The soaking pits discussed include reversing regenerative and one-way fired with recuperators.

Mechanical Insert Repair in the Steel Industry

By R. L. RECTENWALD
Metalock Corporation of Pennsylvania

▲ COLD mechanical repairs were formally introduced in the steel industry at the Buffalo District Section meeting of AISE in April, 1946. Since that time this type of mechanical repair has been generally accepted in the steel industry and has proved to be a most economical and expeditious method of restoring wrecked machinery. Although cold mechanical repairs have passed through a stage of development and were used successfully on industrial and marine equipment for the past twelve years, the process has found new application on heavy steel mill equipment.

Mechanical repair was developed principally for cast iron sections, but it should be emphasized that it may be applied economically to any type of ferrous or nonferrous metal. The physical form, size and location of the fractured section frequently is the determining factor when considering the most desirable method of repair.

In the repair of any casting or weldaments by fusion methods the problem of shrinkage of the weld metal is difficult to overcome. This shrinkage invariably results in harmful residual stresses, warpage, and frequently in failure in the repaired sections while the weld is cooling. It is true that preheating and normalizing after welding relieves some residual stress, but to do this properly, the machine must be disassembled and heat treated uniformly throughout the entire unit. It is impossible to make a weld of any kind without subsequent shrinkage, and in restrained sections where there is no compensation for the shrinkage, the weld is a very unsatisfactory method of repair. The economical aspects are immediately apparent when we consider dismantling some of the large equipment such as large compressors, diesel and steam engines and heavy steel mill equipment. Loss of production also is an item which may far outweigh all other costs on such a project.

The patented mechanical methods discussed in the paper join metals without the use of heat and without the distress which accompanies fusion temperatures. The basic insert consists of a forged bar of high strength alloy which is crimped at regular intervals so that it has the appearance of a number of cylinders joined by straight sections of uniform length. The cylindrical sections are commonly called "lugs" and the shear resistance or holding strength depends upon the number of "lugs" anchored on each side of the fracture. The "locks" are installed in slots across the fracture to a depth of 75 to 90 per cent through the section. The slots are prepared by drilling a series of holes equal to the number of lugs on the lock used. The holes are accurately spaced with a drilling template which is designed to leave a web about $\frac{1}{4}$ the diameter of the hole between the holes. The web is then removed by cutting between holes with special pneumatic tools. The slots are accurately sized to give a shear fit when the "locks" are driven in. Each lock is upset and swelled into the slot by cold working before the successive locks are driven in to form multiple layers. In a section three inches thick, locks of $\frac{1}{4}$ to $\frac{5}{16}$ in. thick would be used. Depending upon the size used, the number of locks in each slot would probably be from seven to ten, coldworked and swelled one over the other until the slot is full of "locks." The spacing of the lock sets in this case would be about 1 to $1\frac{1}{4}$ in. between centers. The sets of multiple locks are spaced along the fracture in line with the apparent stress.

After all locks have been installed the fracture is filled by a series of studs or a combination of studs and dowels which are tangent to each other. The "lacing" is upset much the same as the "locks" and a continuous line of metal is thus caulked into the fracture, giving a pressure-tight joint and serving also as the means to preload the locks in tension. This preloading of the locks is a very important feature of the repair because it is the means by which we avoid fatigue failure through reversals of stress in the locks. The preloading is also insurance against any looseness in the repaired section. The resulting joint efficiency in cast iron is frequently 100 per cent or better but is reduced in steel inversely as tensile strength increases.

Water Works Maintenance

By GEORGE H. DANN
Philadelphia Suburban Water Company

▲ MAINTENANCE of a water works system starts the day the water system is placed in service.

Leak surveys—pipe locators—Immediately the question arises of maintaining the system in as near to its original condition as possible. A method of checking leakage is of primary importance. In order to do this it is necessary to have a complete piping layout plan of your plant.

If this piping plan is not available, there are pipe locators to locate these underground structures. If and when they are located, there is also in use standard leak locating machines which amplify the vibrations of

water leaving the pipe and then filter out extraneous vibrations that are not in the same wave band as leak vibrations.

Loss of head tests—It is also possible by means of a pitometer rod and a U-tube with pressure gages a known distance apart and with their elevation co-related, to develop a hydraulic slope which will indicate bottlenecks such as partly closed valves, corroded fittings, undersized pipes and other maladies common to the plant engineer.

Cleaning and coating—If by tests it is found that a pipe line has lost a sizable amount of its original carrying capacity, it is feasible to clean and coat this pipe, bringing the carrying capacity to a point that is comparable to its original condition.

Pipe sizing—It has been the experience of many water works men in connection with complaints in industrial plants that the piping system of these plants has grown like "Topsy." In many cases the new piping has been properly sized but it has been found that many times a new 3 in. line, if traced back to its supply, connects to a 1 or a 1½ in. supply line. Care should be exercised to consider not only the present requirements but also the ultimate requirements going to be placed on a pipe line during its period of service.

Standpipe painting—Steel water tanks should receive careful annual inspection. Paint has been and still is a proven method for the protection of steel tanks. However, the best paints will not adhere to rust and unless the steel has been properly cleaned of all loose paint, rust, and thoroughly wire brushed, the results will not be good. However, after the metal has been properly prepared, the use of good paint is a real economy since labor is a great factor in the cost of painting, amounting to approximately 80 per cent of the cost. It has been the judgment of many water works men to paint the outside of standpipes and to hot-coat the inside with a bitumastic material.

Electrolysis and corrosion — Corrosion has varied phases. There is the electrolysis or corrosion due to stray railroad currents; there is corrosion caused by sulphate reducing bacteria; differential aeration is another cause of serious corrosion and differences in acidity. These are the most serious forms of corrosion and only are described briefly here. Many other causes such as dissimilar metal corrosion, cavitation, metal fatigue, etc., can be mentioned.

Electrical Equipment for Rolling Cold Strip at 70 Mph

By WILLIAM E. MILLER
Steel Mill Division, General Electric Company

▲ THERE are now five tandem cold strip mills in service with individual generator control. The first of these, a five stand tinplate mill, was placed in service in October, 1947 at the Aliquippa works of the Jones and Laughlin Steel Corporation. In addition to being the first mill to go into service with the new individual generator control system, this mill is unique in that it is the first tandem mill with individual roll drives on the last three stands, the first with rotating regulator controlled screwdowns, and the first to apply and regularly use X-ray equipment for measurement of finished gage.

Within its short life, the performance of this mill has made history and has been widely publicized. The J&L mill is known as the "fastest rolling mill in the world" having rolled tinplate at over 6200 fpm, considerably more than a mile a minute. The screwdowns are considered to be the fastest in response and speed of operation of any tandem mill. The accuracy and reliability of the X-ray gage have caused it to become an indispensable part of this high speed mill. The fruits of these and the other engineering achievements incorporated into this mill have been the rolling of record quantities of quality tinplate.

The new mill will roll strip up to 36 inches wide and will finish to gage of 0.008 inches and less from strip of up to 0.109. When rolling at 6000 fpm, a 15-ton coil can be rolled into tinplate in about 5 minutes.

Combined the motors have a nominal capacity of 16,850 hp and are capable of a continuous overload rating of 20,100 hp. There are two 10,000 hp motor-generator sets each with three generators.

Use of a separate generator for each stand considerably increases the flexibility of the tandem mill. Adjustments between mill stands can be made by generator voltage control as well as by motor field control. IR compensation may be obtained without the high current series booster generators. Also, the heavily supported high current bus is not required.

Rotating type regulating systems are used for the main mill speed control, twin drive regulating systems, reel tension control, for maintaining constant reactive kva, and for the adjustable voltage screwdown equipment.

The engineering problems encountered in the design of the electric control system for a modern high speed tandem mill are as interesting and as intricate as those encountered in any field of engineering. Not only must the system be designed for exacting steady state operating conditions, but it must have a high speed of response for operation under transient conditions. Thus, it was decided to apply to steel mill control systems, the analytical design methods developed and used so successfully during the war in determining the transient performance of gunfire control systems. The basic design method is outlined. The resultant frequency response for the voltage regulating system with IR compensation is shown.

There are now four tandem mills in service with rotating regulator control systems like the one at J&L. All of these control systems were designed using the methods outlined. Results have been gratifying in that the regulating systems have performed as predicted and record breaking production achieved after only a few months of operation.

Review of D-c Drives on Runout Tables and Coilers

By I. N. TULL
Republic Steel Corporation

▲ This review of a controversial subject reminisces to some degree on the background of the pros and cons which determined the selection of d-c motors in place of

the induction motors universally used in such runout table and coiler applications previously.

Relative costs of operation, the various kinds of troubles experienced and remedies for them, advantages and disadvantages developed over a period of eleven years operation of the d-c system are covered in order to answer the points at issue.

Improved Flying Shear Drive

By J. RAYMOND ERBE
Industry Engineering Department
Westinghouse Electric Corporation

▲THIS paper describes a flying shear drive which was recently installed in a continuous hot strip mill which, it is believed, has several advantages over previous drives of this type. The basic elements of this drive are a motor-generator set, direct connected shear motor, and a combination rotating regulator and electronic control.

A discussion of the requirements of the application as well as the factors which determined this design are presented. Comparisons are drawn between this and previous designs.

Tests which have been made on this application are discussed and evaluated. The results are compared with the factors which influenced this design pointing out the degree to which the various conditions have been met. Illustrations showing test data and installation views will be used to illustrate the paper.

A Network System for Dynamic Lowering Hoist Control

By D. L. PETTIT, Square D Company

▲ A unique contactor sequence and resistor network are combined to produce very effective dynamic lowering control of a d-c series, hoist motor. Re-use of resistor sections provides for more conservative rating of the bank. Two spring closed contactors for dynamic lowering increase safety and improve control at slower speeds. The circuit is designed for low commutating peaks—minimizing contact erosion as well as reducing motor commutator and brush maintenance. Step-by-step examination of the circuit is made. Supporting oscillograms of current peaks are included.

Magnetorque A-c Crane Control

By W. F. WENDELBURG and F. M. BLUM
Harnischfeger Corporation

▲ THE magnetorque unit was introduced to the general public in the year 1942 on large excavating machinery. Here the unit was used as a clutch to replace frictional clutches previously used on large earth moving machinery. These clutches in this application overcame one of the greatest sources of maintenance, inasmuch as they used magnetic lines of force to transmit power from the revolving shaft to the power driven units, instead of the usual frictional linings which caused considerable wear and maintenance. Since that time large excavators have had phenomenal success with the use of this clutch. However, on overhead traveling cranes this unit is used as a brake rather than a clutch. Alternating current powered cranes now provide the same splendid speed control as what was thought only possible on direct current powered cranes. In the past, electric overhead traveling cranes have been powered by direct current motors because of the desirable speed characteristics obtained for the hoist motion when using dynamic lowering control.

Because of the availability of alternating current power supply along with its economical advantages, great strides have been made to improve alternating current control to equal that obtained with direct current. It has also been desirable to eliminate the mechanical load brake on alternating current cranes, inasmuch as it is found on direct current dynamic lowering operated cranes that these were more trouble-free. A brief discussion of the various schemes of control using a wound rotor induction motor are presented. These include the mechanical load brake, regenerative lowering, countertorque, direct current braking, single phase lowering, adjustable unbalanced voltage and variable unbalanced voltage control systems. The most recently developed system is magnetorque control. This unique system utilizing an eddy current brake compels the hoist motor to operate effectively at reduced speeds.

The mechanical construction of a magnetorque brake and its mounting in the hoist mechanism is completely described. Curves illustrating the development of this control and its final results are given. An analysis of the control circuit taken step by step and the outstanding safety features such as off position braking, as well as the all position auxiliary braking, will aid in revealing the characteristics of the control. This new control actually excels that of d-c dynamic lowering crane control. The result of tests conducted on the standard crane hoist unit in regard to motor currents and heating are also presented.

Designing the Proper Equipment for Extracting Ingots from the Molds

By H. W. BALL
The Morgan Engineering Company

▲ WHEN the molten metal from the open hearth furnaces has been poured into the molds to cool, it forms an ingot. The problem of extracting this ingot from the mold is the duty of the stripper crane. There are several types of molds and ingots. There are the big-end-up with hot top, the big-end-down, and the big-end-up flush type ingots. The molds vary in size and design. The hot tops follow no particular standard. The stripper crane then must be so designed that it can handle this wide variation and do a good job.

There are five distinct types of stripper cranes:

1. *Electric overhead ingot stripping crane*—The normal lift on this crane is on the average of 40 tons live load or a total of about 65 tons when one includes the

weight of the stripping mechanism. Its main strength lies in its ability to exert a force up to about a maximum of 900 tons. It is capable of handling all types of molds and ingots, providing sufficient data is obtained while in the process of being designed. Some of the problems encountered in designing this type of stripper are the gripping range, angularities of the hot tops, the location of the lugs on the sides of the molds, the gripping force of the tongs, the design of the bits, the material of which the bits are made, problem of lubrication, and the proper air conditioning.

2. *Electrically operated stationary ingot stripper*—Along with the overhead strippers some steel mills require stationary strippers for stripping inverted molds only. The operation of these strippers is similar to the overhead type.

3. *Hydraulic operated stationary ingot stripper*—This type performs in a similar manner to the electrically operated stationary ingot stripper. However, it is the writer's opinion that when strippers have a capacity of over 200 tons they should be of the hydraulic operated type. With this design, one has been confined to stripping the inverted type of ingots only. However, a stationary stripper is being designed for stripping both big-end-down and big-end-up ingots.

4. *Auxiliary or hook-on type of ingot stripper mechanism*—Some of the steel plants having the standard overhead stripper for stripping big-end-down ingots only, purchase what is known as an auxiliary stripping unit. This auxiliary stripping unit consists of tongs for gripping the hot top and links for holding down the mold while in the process of stripping ingots.

5. *Horizontal hydraulic ingot stripper with ingot mold tilting machine and ingot mold car*—Stripping ingots from molds on a productive basis can be done very well by means of a horizontal hydraulic stripper together with tilting device and ingot mold car.

Training Instrument Mechanics at Sparrows Point

By F. R. PULLEN
Bethlehem Steel Company

▲ DURING stages of rapid business expansion, the problem of securing sufficiently trained personnel tends to overshadow all others. This problem exists regardless of the size of the working force and is especially important when new workers must be employed.

The problem of obtaining adequately trained instrument maintenance personnel has been made more difficult by the great strides made in recent years by all of the instrument makers. It is no longer possible to add the work of instrument maintenance to the duties of other maintenance men as the modern instruments and controls require the skill and experience of instrument specialists.

Instrument mechanics at Sparrows Point formerly were trained at the plant of one or more of the instrument makers. This plan was later replaced by a series of short periodic courses taught by various members of the fuel department who were assisted by a service engineer of some of the instrument makers. These courses were combined with on-the-job training. While this was an improvement over the previous training program, the results obtained were not thoroughly satisfactory.

A thorough study of the problem was made and an apprentice training program was developed. In addition to courses in Instrument and Control, Theory and Problems, it was decided to include courses in Blue Print Reading and Mechanical Drawing; Mathematics; Electrical Theory; Electronics; Fuels, Combusion and Furnace; Economics; Ceramics; Metallurgy; and Report Writing. Certain of these courses will be taught by full time instructors of the Training Department of the Sparrows Point plant, and the remainder will be taught by the apprentice counsellor in the Fuel Department.

The entire course will be eight thousand hours in length with from six to eight hours per week of classroom work on the above subjects. The remainder of the week to be spent in on-the-job training under the supervision of the apprentice counsellor.

Upon completion of the apprentice training program, the apprentice will become a first class instrument mechanic.

Fuel Oil in the Steel Industry

By A. J. FISHER
Bethlehem Steel Company

▲ THE paper deals with the trends of fuel oil in the steel industry—the past, present and probable future trends. Tables showing the estimated mineral fuel reserves of the U. S. A., world crude oil production, U.S.A. refining input-output, and detailed distribution of gasoline, kerosene, distillate fuel oil, and residual fuel oil in the U.S.A. for the past several years are shown and discussed.

The steps necessary to change a fuel oil consuming integrated steel plant to a complete coal basis are outlined. Many types of typical applications of fuel oil burning, showing burners, control and instrumentation, are included.

High Temperature Lubricants and their Evolution

By G. L. SUMNER
Westinghouse Electric Corporation

▲ THE ever increasing demand for lubricants capable of withstanding high temperatures is indicated by NEMA classifications of motor insulations. These include Class O, Class A, Class B, and Class H designed to withstand temperature hot spots of 90, 105, 130, and 180 C respectively. Bearings and lubricants must be found to function at these temperatures.

The limitations of orthodox greases (mineral oil dispersions in soaps) and ordinary laboratory tests for evaluating them for use in antifriction bearings operating at high temperatures are discussed.

The paper describes a method for evaluating greases which employs 12 size 310 ball bearings, individually housed, and ambiently heated, that may be run at variable conditions of speed and temperature. Thus, service conditions under which a given grease will oper-

ate may be simulated. At temperatures of 100 C and above heat stabilized bearings should be used to prevent austenite growth in the metal.

Liquefied Petroleum Gases for the Steel Industry

By FRANCIS E. DRAKE
Pacific Gas Corporation

▲ THE natural gas reserves of this country as of January 1, 1948 are reported by the American Gas Association to be 165,930,000,000,000 cubic feet (165.93 trillion cubic feet). The total natural gas consumption in the U.S.A. for the same period and from the same sources was 2,503,637,000,000 cubic feet. The steel industry during 1946 used 224,000,000,000 cubic feet. This is, as one can see, roughly 10 per cent of the natural gas consumption of the country for the same year, it being 2,194,948,000,000 cubic feet.

The oil industry also plays a great part in the making and processing of steel. During 1947, however, the refineries of this country refined more crude than was produced here, having to import some 310,500 barrels each day to keep up with their output. The steel industry during 1946 used 1,783,180,070 gallons (42,457,000 barrels).

The crude oil reserve in the U.S.A. is some 11.6 times greater than the 1,856,107,000 barrels produced. The world reserves and potential production are greatly in excess of those of the U.S.A., but for availability on these shores pipe lines, boats and tank cars are needed in abundance.

The latest survey of the gas industry made by the American Gas Association shows that approximately 4 per cent of the steel industry output over the next year will be needed by the natural gas industry to complete its projected lines and plants during the ensuing 18 months. Whereas the total pipe production by the steel industry in 1947 was 1,200,000 tons, it is estimated that the gas industry for the next 18 months will require 3,838,000 tons. This increase in tonnage is caused more by pipe size rather than mileage. The future is going to require 92 per cent of all pipe 20, 26 and 30 in. in diameter, whereas in 1946 but 56 per cent was required of those sizes. The smaller sizes are reduced in percentage correspondingly. Some pipe line firms have made the statement that if they obtain all the pipe they require it will be 5 years before they can catch up with their program. In the meantime, demand continues in undiminished proportions.

Liquefied petroleum gas, "propane," is not only a stop-gap, but is a most satisfactory substitute for natural gas, not only at times of shortages but at other times as well. Having a dew point of —44 F, and a vapor pressure of 92 psi at 60 F, it makes a perfect gas to blend with air as a substitute and for augmentation for dwindling natural gas supply in the winter time. It not only can be substituted in percentages but can also supplant the other gas in its entirety without changing burners and, in most cases, without even readjusting air shutters.

This annual natural gas winter shortage is not one that is of recent occurrence, but is one that has been going on annually ever since the product was harnessed and utilized. Industry is hard hit each winter, but the hardest hit are the employees who are deprived of work and livelihood during that period of shutdown. This can all be obviated by each industry installing a propane augmentation plant designed for that particular situation and for the prevailing general shutdown period of that location. Some industries are required to shutdown for days while others for weeks.

The steel industry, with weekly wages of $30,800,000, could ill afford the 4 to 5 week shutdown last winter, not only from the employees' standpoint, but from the production and profit loss to the industry as well.

An electrical equipment manufacturing plant installed a propane augmentation unit last year. The company employs 25,000 hands, of which number not less than 10,000 are out of work during a shutdown period. For 15 days during January that plant had no normal gas supply 100 per cent of the time, and for the remainder of 3 weeks it was out of gas from 25 to 75 per cent of the the time. During that period of shortage the propane-air plant took on the load and continued without interruption until the regular supply was returned to the system. $100,000 was invested in that plant, over $2,280,000 saved in payroll to the employees and community merchants, and the management made the statement after the first day's operation that the plant had paid for itself in its first four hours of operation. This is only one of many instances that might be cited as a glowing example of what might be done to increase steel plant capacity during this period when foreign aid, defense and standard domestic requirements are putting such a tremendous pressure upon the steel industry.

Modern Sealing Devices for the Steel Industry

By R. A. KRAUS
Republic Steel Corporation

▲ WITH the continued progress in design of higher capacity plain and antifriction bearings, as well as the steadily mounting working pressure and scope of application of hydraulic devices in heavy industry, we find that all too frequently the necessary sealing devices incorporated in the mechanism will frequently become the weakest link. Bearings which were designed to operate efficiently for long periods will often fail prematurely due to the inability of a sealing device to exclude outside contamination from the lubricating medium. Similarly, other seal failures may so reduce the amount of lubricant available to bearings, gears and other moving parts, that premature failure is impossible to prevent without the use of undue labor to increase the rate of lubricant application. In many cases premature failures of this type mean the unscheduled shutdown of vital production equipment with a resulting loss of unrecoverable production.

With this thought in mind, it behooves management to insist that the engineering and maintenance groups continually keep abreast of seal device progress, so that the best type seal will be used for each application. As improvements in the methods of sealing out solid and fluid contaminants, or the more efficient retention of

lubricants or other fluids are developed and proven, these groups should avail themselves of the new development as the opportunity permits, in order to promote fewer production delays as well as a generally decreased maintenance cost. In a corresponding manner the maintenance force should be thoroughly familiar with all of the factors influencing the useful life of sealing devices, so that upon routine replacement the new sealing member is not installed in such a manner, or under such circumstances, that an early failure is predetermined.

In addition to the critical task of first selecting the proper design of seal and the type of materials of which it is to be manufactured, the maintenance force must also consider in detail such factors as surface finish of the mating member, method of seal assembly, interference fit of the seal in the housing, provision for pressure relief where necessary, amount of shaft runout permissible, optimum shaft hardness, provision for seal lubrication, and other factors which are of considerable magnitude, in order to obtain the desired life cycle of the sealng device. These factors must each be considered in order to obtain the full value of the time spent and the materials used in the assembly of any seal device.

Centrifugal Clarification of Oil in Steel Plants

By CHARLES M. AMBLER
The Sharples Corporation

▲ THE utility of any lubricant is reduced by the impurities it picks up under service conditions. Unless the same critical attention is given to its purification as to its original selection, optimum results during its use will not be obtained. Centrifugal force is particularly suitable for the removal of the kind of impurities normally picked up by oils in steel mill service.

The difference between gravity and centrifugal force is one of degree and the operating principles of centrifuges are described in terms of their gravitational equivalents.

Various combinations of centrifuges with heaters, pumps, gravity tanks and filters, are available for the purification of lubricating oils, cutting oils, quenching oils, hydraulic oils, insulating oils and palm oil. These combinations are illustrated and their operating principles discussed.

Analysis of Cold Mill Design

By FRANK P. DAHLSTROM
Arms-Franklin Corporation

▲ THE paper includes the results of studies made of several types of cold rolling mills and gives, as far as possible, factual data such as basic features of design and operation, together with the forces which are applied to the various rolling elements. Among the mills to be included are the:

1. Conventional 2-high and 4-high.
2. Cluster (6 rolls).
3. Rohn (12 or 20 rolls).
4. Sendzimir.
5. Y-mill.
6. Ring type mill.
7. Kraus mill.
8. Simons mill.
9. Four-high mill with driven back-up rolls.

The paper is a logical development of the basic paper "Power and Pressure Calculations for Rolling Strip," part of which was presented April 27, 1948 at the AISE Spring Conference in Buffalo, New York.

Beam and Channel Roll Design

By ROSS E. BEYNON
Carnegie-Illinois Steel Corporation

▲ THE subject matter of this paper is beam and channel roll design and the paper is intended for beginners in roll design and to acquaint them with some of the ways of rolling beams and channels and the reason for selection of a particular way of design. The paper is divided into four parts. The first part deals with beams rolled with the flanges in the vertical position, the so-called straight method of rolling beams. The designs shown are 7/8, 4, 6, 8, 15, and 24 in. beams both standard and special. Typical mill layouts suitable for rolling the beams are shown.

In the second part, beams rolled by the diagonal method are shown, including a 1 and a 1 7/8 in. beam, two special 5 in. H-beams of different designs, and a 24 in. standard beam of a special diagonal design.

In the third part, roll designs for channels are shown, ranging from 3/4 to 12 in. channels, including standard, car, and ship channels. In the first three parts, the development of beams and channels is traced from the beginning and, in the fourth part, beams rolled on universal beam mills are illustrated. In this part the development of universal beams is traced from the earliest beginning to the present time. Drawings are shown of the principal types of universal beam mills.

Deformation in Rolling

By GEORGE S. MICAN
Carnegie-Illinois Steel Corporation

▲ THIS paper on the fundamentals of hot rolling goes back to the very fundamental conceptions of atomic structure, lattice structure, crystals, and grains. This paper covers cold and hot deformations including single disc and disc cylinder deformations. Among the subjects discussed are hot gate shearing, hot cutter shearing and hot hammer drawing, open forging of prisms, elongation and spread in open forging, die forging and extrusion and drawing. The paper separates rolling into two parts. In one case, the H to W ratio is greater than 2 to 1 and in the other case, the H to W ratio is less than 2 to 1. A discussion of rolling versus forging is also included.

Coal Preparation for Steel Manufacturers

By N. L. DAVIS
Nelson L. Davis Company

▲ THE paper explains the causes leading to stricter requirements for the cleaning of coal which has been mechanically mined for the production of coke for blast furnace use. It embodies a concise explanation of the theory of "Heavy Media" suspensions and the practical use to which such suspensions are put in making float and sink separations of coal for the purpose of efficiently recovering useable fuel from run-of-mine production.

Typical flow sheets of the processing equipment, as well as arrangements for typical coal cleaning plants are given. Some illustrations are shown of the Chicago pilot plant which was constructed for the purpose of proving the various processing units to be used at the 2,000 tons per hour washery being constructed for Jones and Laughlin Steel Corporation at East Fredericktown, Pennsylvania.

Problems in Handling Heavy Coils — Symposium

Conveyors

By J. E. McBRIDE
Palmer-Bee Company

▲ MUCH progress has had to be made in conveyor design in order to keep pace with the increased speed of rolling mills and increased sizes of coils. Chain conveyors are now designed for hot mill coils whose weights run up to 30,000 lb, with the ability to cover distances of 1,000 ft or more, and are designed so that change of direction can be made without damage to thin gage strip. Coilers are timed so that sufficient cooling time takes place during the travel on the conveyor before down-ending and with capacities up to 1500 tons per hour. The basic principle of the conveyor consists of two parallel chains supported on two continuous girders spaced 30 inches apart on centers to allow the arm of the down-ender to pass through. The chain pitch is usually 18 inches with flat tops 6 to 8 inches wide. Every pitch is equipped with a 7 inch diameter, 3 inch face roll made of 5150 steel heat treated and hardened to 60 Rockwell, and equipped with precision roller bearings. This type of chain weighs about 100 lb per foot and runs on a wearing strip of spring steel. The breaking strength is about 250,000 lb. The parallel chain type of conveyor can run only in a straight line and when right angle turns must be made, as is often required, a separate mechanical unit must be interposed to receive the coils from one conveyor and deliver to the one running at a 90 degree direction. The newest type of hot coil conveyor is basically different and consists of a single endless chain running in a horizontal plane and attached to 4-wheel trucks at evenly spaced intervals of 6 ft. This unit has a capacity of two coils per minute or 120 per hour. This setup has a number of desirable features not possible with the parallel chain design.

Coilers for cold reducing mills have become even larger than that of the hot mill and cold coilers from the continuous pickling have reached a weight of 75,000 lb. Such coilers are handled by troughed roller conveyors which are operated by a single chain equipped with knock-over pusher dogs. Final travel is usually on a feeder conveyor of the platform type which is about 20 to 30 feet long and built close to the floor.

Cranes

By R. G. BIRKIN
Cleveland Crane & Engineering Company

▲ THE demand for sheet mill products has greatly accelerated the trend towards the use of heavier coils. The use of heavier coils not only increases the production rate, but also increases the yield.

This trend has brought with it many problems in coiling, annealing and handling. This paper deals with the effects on overhead traveling cranes brought about by the use of heavier coils.

The lightest cranes in most strip mills are of 15-ton capacity. The heaviest coils are rapidly approaching 30,000 pounds, and since crane handling of coils over 30,000 pounds seems indicated, some provision for extra crane capacity must be provided.

This is being done generally in two ways:

1. The purchase of a heavier capacity trolley and hoist to operate on an existing bridge.
2. The modification of an existing 15-ton hoist to handle 25 tons by increasing the parts of hoist rope.

These two solutions can be used because modern mill cranes built to the A.I.S.E. specifications are designed for low stresses, and the increased live load does not materially increase the stresses.

A secondary trend towards larger slabs will in all probability require the purchase of heavier cranes in the slab yard.

Trucks

By B. I. ULINSKI
Electric Industrial Truck Association

▲ BATTERY-POWERED ram trucks have solved the problem of handling strip coils of increasing size and weight for more than a decade and have become an indispensable tool in steel mills. Once enormous 6000-lb coils have grown to 30,000 lb and industrial trucks for handling 60,000-lb coils are on the way. The ultimate size of electric trucks for this service is limited only by the needs of industry.

Ram truck handling has advanced rapidly for two principal reasons: greater flexibility of operation over unlimited areas as compared with other common handling equipment, and ability of the electric industrial truck industry to meet the demand for greater load capacity and to develop new design features that have

simplified, speeded up and made strip coil handling operations most dependable.

Modern designs of battery-powered ram trucks have matured from their early make-shift stage when coils were handled by adaptations of the first fork trucks. Difficult engineering design problems have been solved and others are being solved. Higher load capacity requires higher power, which has been supplied by batteries of greater capacity, more powerful motors, and control equipment of higher rating. Wheel loading data has required most careful consideration as a basis for design. Engineering factors are not confined to the truck but also require consideration of floor construction in the solution of strip-coil handling problems.

Developments in Sleeve Bearings

By A. B. WILLI, Jr.
Federal Mogul Corporation

▲ THOUGH the sleeve bearing material combinations available today differ but slightly from those used ten to fifteen years ago, design, metallurgical and manufacturing refinements have kept the sleeve bearing industry abreast with the requirements of engine and machine designers.

Tin and lead base babbitts, cadmium alloys, copper-lead mixtures, leaded bronzes, aluminum alloys and silver appear to adequately satisfy the need for sleeve bearing lining materials at the present time. Low carbon steel, cast iron and bronze as backings for these linings are acceptable.

Methods of applying bearing linings to their backings can be divided into four major classifications: (1) by static casting, (2) by centrifugal casting, (3) by electroplating and (4) by application on a continuous steel strip.

Certain modifications in these manufacturing techniques have resulted in reduced production costs, with noteworthy improvements in bearing quality.

The micro-structure of statically cast copper-lead bearings has been materially improved by replacing sand cores with graphite or reusable alloy steel cores.

Multiple spindle, automatic centrifugal casting machines have effected cost reductions with no loss in quality and control.

Great strides in precision electroplating have permitted the development of the now popular lead-tin overplated copper-lead, silver, and bronze bearing types.

The availability of accurately rolled steel strip, improved high-speed presses and die developments were responsible for the low cost, thin wall babbit and copper-lead bearing types.

Though a rather imposing list of bearing material combinations are available, there are a few combinations which dominate the field. This is largely due to the huge quantities consumed by the automotive industry.

In the past year sleeve bearing manufacturers produced on the average 600,000 bearings each working day. Of these, approximately 64 per cent were strip type, thin wall babbitt bearings, 14 per cent were strip type, thin wall copper-lead bearings, with the remaining 22 per cent taken up by at least seven other types. Actually 75 per cent of the bearings produced were lined with either lead or tin base babbitt.

Bearing cost is a determining factor in many selections. In an effort to combat rising costs, engines and machines are being designed to utilize the most economical bearing available. With the heavy duty, copper-lead bearings costing one and a half to two times more than the babbit type, the predominant use of babbitt can be readily understood.

Preventive Maintenance of Electric Oils

By C. J. EGGER
Bowser, Inc.

▲ THE basic facts governing service degradation of petroleum oils for electrical service may be briefly expressed. These oils are mixtures of hydrocarbons of varying molecular weights and structures, each obeying the laws governing chemical combination, the degree and rate of response depending upon both molecular weight and chemical structure of each individual petroleum hydrocarbon. Chemical action as well as pollution of electrical oils will occur if the oil be employed in circumstances which afford the incidence of external agents, or in juxtaposition with substances which will react or catalyze chemical reactions.

By far the combination of petroleum hydrocarbons with oxygen is the most widespread reaction which normally occurs in most service applications. Oxidation of the petroleum proceeds to produce acids, both low molecular weight and high molecular weight. Simultaneously, water vapor condenses, to form globules of water suspended in the oil. The low molecular weight acids or corrosive acids, are extracted from the oil to dissolve in the water. The solution of corrosive acids inevitably come into contact with metal surfaces and chemical combination takes place forming metallic salts of these acids. These metallic salts are insoluble in the water associated with the corrosive acids and are also insoluble in the petroleum oil. The higher molecular weight acids and other oxidation products, however, have a distinct affinity for these compounds with the result that these products are withdrawn from solution to form an intimate emulsion of water, metallic soaps and petroleum oxidation products. This emulsion acts as a nucleus for the depostion of small solid particles such as carbon and metallic oxides, and appears as a body totally separate from the petroleum oil and is called sludge.

It has been established that the presence in solution of oxidation products results in a decrease in dielectric strength approximately paralleling the increase in concentration of dissolved substances. The deposition of resinous compounds upon the cores and windings of transformers not only prevents adequate heat transfer through the oil, but also retards free circulation of the oil.

The perfect solution to the problem is to refuse to permit the conditions creating it to exist. This is a state of affairs seldom realizable in commercial operations, and consequently more effort is usually directed toward diminution of adverse effects than is spent profitably to

eliminate them. Several objectives seem to be reasonably indicated and may be expressed thus:

1. The oil selected for a specific application should be the most stable and oxidation-resistant that is available or can be developed.
2. Conditions of operation and design should be so controlled that the operation of the mechanism should not give rise to or promote changes in the composition or constitution of the oil employed, this to be achieved without sacrifice of any part of the efficiency of the mechanism.
3. Means should be provided for the removal of the external agents such as air, water, or other products entering into, or necessary for the undesirable chemical changes. By removing these substances as they are introduced into the system, no possibility can arise of the critical concentration of these agents being allowed to develop, that is, a concentration in which combination with petroleum by hydrocarbons can be initiated.

The Use of Rust Preventives in the Maintenance of Steel Structures

By JOSEPH G. SURCHEK
Dearborn Chemical Company

▲ THIS paper deals with the petroleum base, non-drying protective coatings which have found acceptance in industry for the protection of steel structures under various adverse weathering conditions. Because of their inherent properties of flexibility, high wetting power, and waterproofness, these materials find application where the use of hard drying type protective coatings is not practical.

Some of the most effective of these materials, namely, the high melting point waxy types, formerly were restricted in use because of the difficulty in application. It is now possible to apply these materials quickly and effectively by a method utilizing heat and fluid pressure. This method can be used as effectively on flat surfaces as in restricted areas such as the interior of pipe. An interesting method of application to interior of water pipe is discussed. The soft grease or waxy types can be applied easily by use of high pressure atomizing equipment now commercially available. Various unique applications of these materials are discussed.

Mandrel Type Hot Strip Coiler

By G. E. FARRINGTON
E. W. Bliss Company

▲ COILERS of various designs have been used for the reeling of strip since the early days of metal rolling. As the speed and width of the strip increased and the gage became lighter, coilers were redesigned to handle the production. In 1937, the author's company radically departed from the then conventional hot strip coiler design and installed two mandrel type coilers. These coilers were radical in their construction in that a collapsible driven mandrel was used for determining the inside diameter of the coil and for maintaining tension while coiling. These coilers have been in operation continuously since 1938 with a third coiler added to increase production early in 1947.

This paper deals with the latest design of the mandrel type coiler, and discusses the general design of both mechanical and electrical equipment supplied, as well as briefly touching on the new runout tables and coil handling facilities for handling the finished coils, after being discharged from the coiler so as to provide the maximum protection to strip edge.

Strip Welding

By F. R. THOMPSON and F. W. WALDSCHUTZ
Mesta Machine Company

▲ RESISTANCE welding is the best known method of joining two or more coils together. It produces a joint that is as strong as the parent metal and provides a continuous strip through the pickle line. It is the means of forming large coils at the end of the pickle line for rolling through the tandem mill without difficulty and for any further working that the finished sheet requires.

The welding unit consists of a stationary welding head which holds one polarity clamping die insulated from its base, and a movable welding head with the other polarity clamping die which is not insulated. A retractable gage is arranged between the dies against which the ends of the strips are aligned and properly spaced. After the strips are clamped the gage is withdrawn.

A suitable cam operated mechanism closes the gap left by the gage until the strip ends are just touching. The welding current is turned on and the feeding mechanism slowly moves the ends of the strip together to produce flashing and bring the strip ends to proper welding temperature.

As soon as welding temperature is reached, the push-up takes place to quickly forge the heated ends together and complete the weld. Low carbon steel requires an ordinary fast push-up. Alloy steel and other special metals require faster push-up and variable clamping, which facts have brought about a new development in the design of an all-hydraulic resistance welder. To make a successful weld, the strip must be uniform in width, gage and soundness of metal.

The removal of the excess metal after welding requires a separate machine, the most common of which is the plow-type trimmer, which trims without stopping the strip. Another machine is the cross-cut trimmer in which multiple knives move across the width of the strip while the strip is stopped. A third machine is the rotary trimmer which also requires stopping of the strip to remove excess metal.

The advantages of welding two strips together are lost if the strip breaks in the tandem mill. The number of breaks in heavy gage material is negligible. With light gage material a typical report shows 386 welds with 1.3 per cent breaks in the weld.

IRON AND STEEL EXPOSITION FLOOR PLANS

Cleveland Public Auditorium

Cleveland, Ohio

ARENA—Street Floor

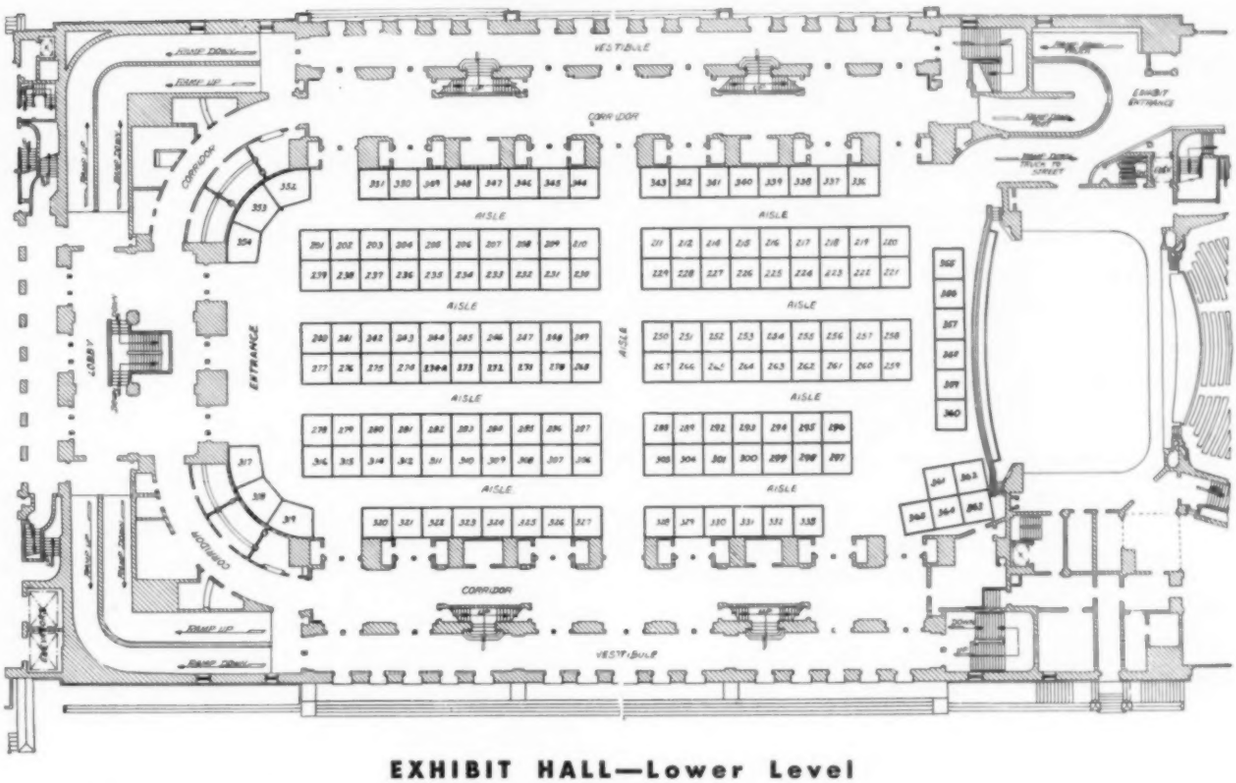
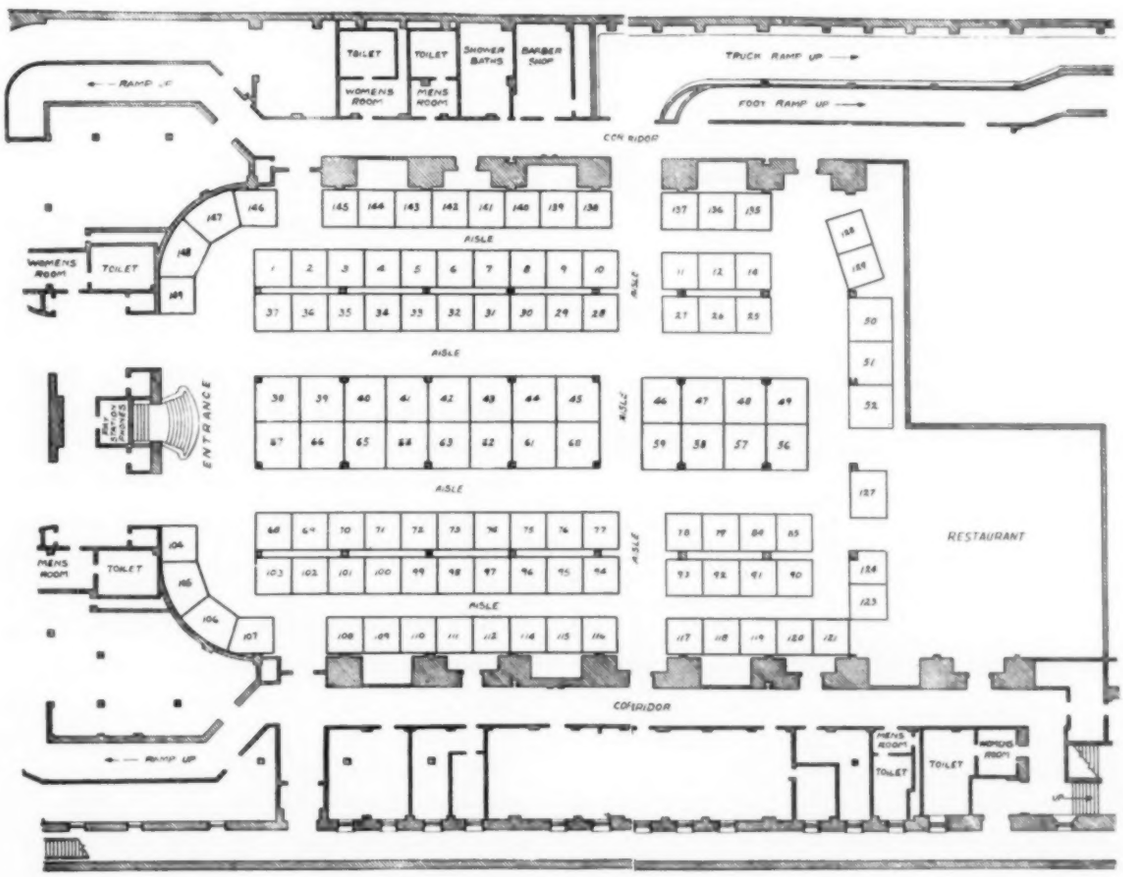


EXHIBIT HALL—Lower Level



EXPOSITION HOURS

TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
SEPTEMBER 28	SEPTEMBER 29	SEPTEMBER 30	OCTOBER 1
10:00 a. m. - 10:00 p. m.	10:00 a. m. - 10:00 p. m.	10:00 a. m. - 5:30 p. m.	10:00 a. m. - 4:00 p. m.

LIST OF EXHIBITORS

A

Ajax Flexible Coupling Company, Inc. — 94, 95.
Allen-Bradley Company — 308, 309.
Allis-Chalmers Manufacturing Company — 33, 34, 35, 36, 37.
Aluminum Company of America — 207, 208, 209.
American Brake Shoe Company — 294, 295, 296, 297, 298, 299.
American Hoist and Derrick Company — 284, 285.
Amsler Morton Corporation — 317.
Appleton Electric Company — 300, 301.
Askania Regulator Company — 242, 243.
Association of Iron and Steel Engineers — 9, 10.
Automatic Transportation Company — 38, 39, 66, 67.

B

Baker-Raulang Company — 361, 362, 363, 364, 365.
Bantam Bearings Division, The Torrington Company — 318.
Bearing Service Company — 320, 321.
Benjamin Electric Manufacturing Company — 128, 129.
Biddle Company, James G. — 231.
Blaw-Knox Company — 276, 277.
Bloom Engineering Company, Inc. — 348.
Brosius Company, Edgar E. — 114.
Bulldog Electric Products Company — 91, 92, 93.
Burndy Engineering Company, Inc. — 138, 139.

C

Carbone Corporation, The — 273.
Chicago Rawhide Manufacturing Company — 232.
Clark Controller Company, The — 68, 69, 70.
Cleveland Crane and Engineering Company, The — 255.
Cleveland Worm & Gear Company, The — 244, 245, 246.
Clipper Manufacturing Company, The — 219, 220.
Crocker-Wheeler Division, Joshua Hendy Iron Works — 271, 272.
Crouse-Hinds Company — 340, 341.
Cutler-Hammer, Inc. — 46, 47, 48, 49.

D

De Laval Separator Company, The — 344.
Delta-Star Electric Company — 216, 217.
Dixon Crucible Company, Joseph — 111.
Dowell, Incorporated — 324, 325.
Dravo Corporation — 274, 274A, 275.

E

Eastern Pipe Maintenance Company — 218.
Edison, Inc., Thomas A., Edison Storage Battery Division — 224, 225.
Electric Controller & Manufacturing Company, The — 135, 136, 137.
Electric Products Company, The — 30, 31.
Electric Storage Battery Company, The — 326, 327.
Electro Chemical Process Division, Blaw-Knox Company — 276, 277.
Elwell-Parker Electric Company, The — 148, 149.
Euclid Crane and Hoist Company, The — 127.

F

Factory Stores Company — 336, 337, 338, 339.
Farmers Engineering & Manufacturing Company — 335.
Farval Corporation — 244, 245, 246.
Federal Electric Products Company — 78, 79.
Fenn College — 96, 97.
Fulton Foundry & Machine Company, Inc. — 65.
Furnace Engineers, Inc. — 330.

G

Garlock Packing Company, The — 311, 312.
General Electric Company — 278, 279, 280, 281, 282, 283.
Gordon Lubricators Division, Blaw-Knox Company — 276, 277.
Gould Storage Battery Corporation — 352.

H

Hagan Corporation — 146, 147.
Heil Process Equipment Corporation — 310.
Heppenstall Company — 62, 63.
Hodson Corporation, The — 223.
Holophane Company, Inc. — 116.
Homestead Valve Manufacturing Company, Inc. — 264, 265.
Hunt & Son, Inc., C. B. — 350, 351.
Hyatt Bearings Division, General Motors Corporation — 286, 287.

I

Industrial Heating — 142.
Iron Age, The — 345, 346.
Iron and Steel Engineer — 102, 103.
Iron Lung — 58, 59.
I-T-E Circuit Breaker Company — 315, 316.

K

Kennametal, Inc. — 143, 144, 145.
Keystone Lubricating Company — 268.
Koppers Company, Inc. — 306, 307.

L

Lewis Foundry and Machine Division, Blaw-Knox Company — 276, 277.
Lincoln Engineering Company — 261, 262.
Linde Air Products Company — 355, 356, 357, 358, 359, 360.
Link-Belt Company — 1, 2, 3, 4.
Lintern Corporation, The — 254.
Lovejoy Flexible Coupling Company — 247.
Lubriplate Division, Fiske Brothers Refining Company — 349.

M

Markal Company — 293.
Martindale Electric Company, The — 32.
McCaskey Register Company, The — 119.
Mesta Machine Company — 288, 289, 304, 305.
Metalock Repair Service, Inc. — 40, 41.
Morganite, Inc. — 210.

N

National Alloy Steel Division, Blaw-Knox Company — 276, 277.
National Carbon Company, Inc. — 355, 356, 357, 358, 359, 360.
National Electric Coil Company — 84, 85.
National Safety Council — 5, 6.

O

Ohio Carbon Company, The — 71.
Ohio Electric Manufacturing Company — 56, 57.
Okonite Company, The — 221, 222.
Otis Elevator Company — 234.
O-Z Electrical Manufacturing Company, Inc. — 117, 118.

P

Pannier Corporation, The — 252, 253.
Penton Publishing Company, The — 331, 332.
Pittsburgh Rolls Division, Blaw-Knox Company — 276, 277.
Post-Glover Electric Company, The — 76, 77.
Powermatic Ventilator Company — 58, 59.
Power Piping Division, Blaw-Knox Company — 276, 277.
Pyle-National Company, The — 98, 99.

R

Railway and Industrial Engineering Company —314.
Ramtite Company, The — 328, 329.
Ready-Power Company, The — 140, 141.
Reliance Electric and Engineering Company — 44, 45, 60, 61.
Rockbestos Products Corporation — 235.
Roller Smith Division, Realty & Industrial Corp. — 50, 51, 52.
Rollway Bearing Company, Inc. — 205.
Rust-Oleum Corporation — 64.

S

Salem Engineering Company — 230.
Shell Oil Company, Inc. — 353, 354.
Signode Steel Strapping Company — 100, 101.
SKF Industries, Inc. — 259, 260.
Socony-Vacuum Oil Company, Inc. — 266, 267.
Speer Carbon Company — 270.
Square D Company — 72, 73, 74, 75.
Stewart-Warner Corporation — 250, 251.
Sutton Engineering Company — 42, 43.

T

Texas Company, The — 342, 343.
Thomas & Betts Company, The — 322, 323.
Tide Water Associated Oil Company — 108, 109.
Timken Roller Bearing Company, The — 104, 105, 106, 107.
Tool Steel Gear & Pinion Company, The — 240, 241.
Towmotor Corporation — 11, 12, 26, 27.
Trabon Engineering Corporation — 28, 29.
Trumbull Electric Manufacturing Company, The — 248, 249.

U

Union Carbide and Carbon Corporation — 355, 356, 357, 358, 359, 360.
Union Steel Castings Division, Blaw-Knox Company — 276, 277.
United American Metals Corporation — 263.

W

Wagner Electric Corporation — 256, 257, 258.
Waldron Corporation, John — 292.
Wellman Engineering Company — 233.
Westinghouse Electric Corporation — 201, 202, 203, 204, 236, 237, 238, 239.
Wing Manufacturing Company, L. J. — 347.

Y

Yale and Towne Manufacturing Company, The — 211, 212, 214, 215, 226, 227, 228, 229.

Steel Plant Service Requirements for Cranes

I. E. MADSEN, Standards Engineer
Association of Iron and Steel Engineers

▲ IN March of 1947, when the Association of Iron and Steel Engineers crane specifications committee were going over the proposed draft of the crane specifications, one of the subjects under consideration was a set of service factors which could be applied when setting up bridge motor horsepower requirements. While the subject was under discussion, the question came up as to how much service a crane actually performs. In the informal discussions, one man's estimate would indicate that a particular type crane would operate practically 24 hours a day, 360 days a year, and another man's opinion on the same crane would give an answer which would be only a fraction of this amount. In very few cases, as nearly as could be determined, were such opinions based on other than casual observations. It was therefore suggested that, before any such service clauses be adopted in the specifications, a survey of the steel industry should be made to determine how much service various types of cranes must undergo.

Since that time, a survey has been made of a number of plants in the steel industry (these plants represent more than 50 per cent of the total ingot capacity in the United States). While the survey was being made, it was decided to expand the information which was basically required for motors so as to obtain information on all the various crane components. A composite summary of the results of this survey is included in Table I. This table gives complete information on practically all types of steel mill cranes. In this summary the various types of cranes have been divided into five overall types covering, in general, the departments in which they operate. These types are as follows:

1. Coke plant and blast furnace cranes.
2. Open hearth, electric furnace and bessemer cranes.
3. Ingot handling cranes.
4. Rolling mill cranes.
5. Finishing mill cranes.
6. Miscellaneous cranes.

These classifications are arbitrary and have no significance in themselves, but to a certain degree they follow the various departments as the raw materials in the steel mill are processed into the finished product. The classification was broken down in this way because, although the same type of crane and the same size crane might be used in several departments, their service in these various departments may be widely different.

Across the top of the page, the information on cranes is broken into five different classifications as follows:

1. Crane
2. Bridge
3. Trolley
4. Main hoist
5. Auxiliary hoist

In the first classification under Crane is given information which applies to the crane as a whole. The first column gives the average number of hours' operation in a year, a very important piece of information. These hours are the hours in which any particular part of the crane is in service either the bridge, trolley, main hoist, or auxiliary hoist. Most crane service information to date has been based on this factor, and it was this type of information on which the previous crane service factor for the bearing clauses were based. Such information can be easily obtained by electrical gages which will give the time when the crane draws current. However, such information, on the other hand, may have little significance as far as any particular item on the crane, such as the bridge or hoist, is concerned. Under columns 2 and 3, information is given on crane temperatures or rather, on the atmospheric temperatures in which the crane operates. Such information is significant in crane service, for motors and electrical equipment subjected to relatively light service at a high ambient temperature may burn out more quickly than electrical equipment subjected to severe service under normal ambient temperature.

The next four groups of three columns give three items of information for each one of the four crane motions, or the corresponding motions on special cranes. These items are:

1. Average number of hours' operation in one year.
2. Per cent time on in an operational hour.
3. Number of moves per hour.

We will discuss these items for the bridge motion, and this discussion will apply correspondingly to the other items in this table. The "Average number of hours' operation in one year" is the number of hours' operation of the bridge motion itself. It equals "Average number of hours' operation in one year" times "per cent time as a general rule, the number of hours' operation of the bridge, plus the trolley, plus the main hoist, plus the auxiliary hoist, will be greater than that of the total number of hours' operation of the crane. This is because it is common practice to operate more than one motion at a time. The information on the average number of hours' operation in a year is of importance and essential in the design of any item where fatigue or number of cycles of load or stress is a factor. One of the outstanding examples of this is the determination of the proper size of roller bearings since the load rating is a direct function of the total number of cycles of operation. For example, in the crane specifications, the design life of the crane has been arbitrarily assumed as ten years. Bearings, thus, in the case of an open hearth ladle crane must be designed for a life of 2916 (from

TABLE I

Crane Service Data

	Crane			Bridge			Trolley			Main hoist			Auxiliary hoist		
	Average number of hours operation in one year	Normal ambient temperature during operation	High ambient temperature during operation	Average number of hours operation in one year	Per cent time on in operational hour	Number of moves per hour	Average number of hours operation in one year	Per cent time on in operational hour	Number of moves per hour	Average number of hours operation in one year	Per cent time on in operational hour	Number of lifts per hour	Average number of hours operation in one year	Per cent time on in operational hour	Number of lifts per hour
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Coke Plant and Blast Furnace Cranes:															
Drawing machine (coke pusher)	7200	80	135	3240	45	17	2088	29	9	1296	18	7	1440	20	6
Bucket handling	3240		110	1458	45	19	1458	45	25	2009	62	25	2106	65	27
Stock yard	6840			3078	47	14	3762	55	48	2941	43	38	2736	40	100
Slag handling	5400		100	1670	31	21	1836	34	30	2052	38	21	3240	60	35
Scrap yard	7200			3240	45	30	1440	20	27	4104	57	80			
Cast house	1080			648	60	32	400	37	32	616	57	75	432	40	20
Pig machine						15		90	15		90	4		5	2
Ladle house	1800			360	20	22	630	35	25	576	32	15	846	47	17
Skull cracker	720			36	5		576	80	30	648	90	30	14	2	1
Sand house (bucket)	360			324	90	21	342	95	21	54	15	21	324	90	20
Setting basin	720			360	50	30	108	15	60	180	25	60	216	30	60
Car repair shop	1440			216	15	20	288	20	35	432	30	40	288	20	20
Ore bridge	7560			756	10	10	3780	50	35	454	6	35	3024	40	35
Coke ovens (Coal bridge)	5760			1440	25	15	2880	50	78	634	11	78	2419	42	78
2. Open Hearth, Electric Furnace, Bessemer Cranes:															
Charging machines	6840	91	111	2120	31	98	3146	46	89	1847	27	80	1368	20	88
Hot metal crane (charging)	6480	118	129	2850	44	27	1426	22	32	1750	27	13	2592	40	31
Ladle	6480	101	108	2916	45	33	3110	48	23	1690	26	9	1361	21	18
Metal mixer crane	3600	90	120	648	18	12	1008	28	18	1980	55	20	1080	30	33
Electric furnace charging cranes	2880			864	30	45	864	30	60	1728	60	100			
Stock yard	6480	70	80	1940	30	76	2851	44	89	3110	48	93			
Scrap preparation					10	64		50	64		40	32			
Scrap baler crane	7560			2040	27	40	2268	30	40	3780	50	80			
Scrap shear crane	7560			4990	66	40	1275	17	40	4838	64	80			
Hot top	5400		130	1350	25	55	810	15	57	1890	35	30	2430	45	90
Bucket	5040			2420	48	52	2218	44	49	2066	41	43	1915	38	20
Slag handling	6480			1820	28	25	1944	30	8	2268	35	10			
Cinder yard	5040	70	100	2120	42	55	2621	52	80	3276	65	82	4032	80	25
Skull cracker	6480	42	80	1620	25	70	2592	40	71	3110	48	23	3564	55	37
General service	3960		100	1310	33	22	911	23	26	555	14	23	1584	40	56
3. Ingot Handling Cranes:															
Ingot handling	6840			1500	22	30	1163	17	33	3762	55	17	342	5	28
Soaking pit	3960	122	580	1660	42	42	1703	43	42	2020	51	60	832	21	50
Stripper	4680	50	113	1070	23	38	1638	35	38	2059	44	64	1123	24	31
Mold yard	6120	72	101	2570	42	44	1714	28	63	2815	46	55	612	10	20
4. Rolling Mill Cranes:															
Slab yard	6480	60	100	3629	56	26	1944	30	34	2786	43	30	778	12	16
Slab furnace charging	4680		105	1400	30	40	1640	35	45	2800	60	61	468	10	10
Plate and strip handling	6480	110	112	3694	57	27	1426	22	26	2203	34	41			
Billet mill	4320		108	1690	39	23	1166	27	23	2030	47	31			
Billet shipping	7200	100	100	935	13	10	864	12	10	1800	25	35			
Rail mill	3600		100	1440	40	10	720	20	20	1800	50	30			
Rail loading dock	3240	100		2430	75	20	1620	50	20	1620	50	20			
Rail shipping	7920			3240	41	30	4356	55	30	3722	47	80			
Hot mill	5400		115	1400	26	18	1296	24	22	1188	22	13	1782	33	15
Cold strip mill	6840	75	100	2530	37	20	1984	29	27	1505	22	26	2120	31	24
Coil storage	7920	75	120	5227	66	73	3247	41	72	3485	44	66			
Roll shop	4320	75	90	1730	40	28	1166	27	24	1037	24	19	1080	25	26
Mill service	5040	90	110	1810	36	30	1260	25	30	1663	33	19	1865	37	40
Machine shop	5040			1810	36	31	1410	28	41	1560	31	33	2020	40	30
Cooling building	5760		132	1840	32	26	2189	38	27	2822	49	35			
Inspection and conditioning	3600			1800	50	50	1080	30	45	2520	70	75	180	5	10
Pit cover	5400		100	2700	50	25				1350	25	20	1350	25	25

TABLE I

Crane Service Data

	Crane			Bridge			Trolley			Main hoist			Auxiliary hoist		
	Average number of hours operation in one year	Normal ambient temperature during operation	High ambient temperature during operation	Average number of hours operation in one year	Per cent time on in operational hour	Number of moves per hour	Average number of hours operation in one year	Per cent time on in operational hour	Number of moves per hour	Average number of hours operation in one year	Per cent time on in operational hour	Number of lifts per hour	Average number of hours operation in one year	Per cent time on in operational hour	Number of lifts per hour
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5. Finishing Mill Cranes:															
Slab storage	6480	80	100	1944	30	40	1944	30	40	1944	30	20	324	5	2
Billet yard	3960			1660	42	32	475	12	32	1069	27	45			
Furnace room	4320			2592	60	30	648	15	30	1080	25	30			
Mill service	5040	80	105	1870	37	19	1411	28	23	1562	31	17	1109	22	25
Shipping	5760	70	100	2995	52	35	1382	24	36	2304	40	52			
Warehouse	5040	75	100	2320	46	31	1260	25	32	2419	48	35			
Sorting room	7200			3600	50	60	1800	25	60	2160	30	60			
Scale pit	360			126	35	25	72	20	25	324	90	25	324	90	25
Hot bed	1440			216	15	5	144	10	17	288	20	15			
Pickling	6840	80	110	2800	41	30	1710	25	39	2462	36	47			
Quenching			100		5	2		5	2		5	2			
Tin mill	6840	75	100	2530	37	36	1710	25	41	2394	35	42	684	10	20
Annealing	7200	67	116	2880	40	22	2232	31	24	2016	28	16	2808	39	25
Battery shop	5400			540	10	22	432	8	22	540	10	11			
6. Miscellaneous Cranes:															
Forging manipulators	5400	80	115	2480	46	33	2430	45	30	1134	21	18	108	2	1
Hydraulic forging cranes	8640	80	110	3630	42	17	3197	37	40	3024	35	22			
Warehouse	3960			1700	43	16	713	18	17	990	25	16			
Gantry	5040	70	90	2020	40	34	2268	45	81	2520	50	88			
Repair	1800	80	102	504	28	15	360	20	14	378	21	12	396	22	15
Machine shop	5040	80	90	2068	41	21	1310	26	21	1008	20	12	1512	30	18
Service	1800			610	34	11	288	16	12	450	25	14			
Power house	1080	90	115	270	27	8	270	27	13	260	24	7	230	21	13
Motor room	1080		110	240	22	4	162	15	6	194	18	4	162	15	4

Column 4 of Table I) times 10 or 29,160 hours. Then the appropriate bearing is selected, based on the rpm, which will depend on the bridge motor speed and gear ratio. This information is, however, already calculated for bridge bearings, but when such information is required for other items on the crane, it may be computed just as easily. The life of items such as bearings is not normally a function of peak operation but is a function of the total number of operating cycles which information is given by this column.

On the other hand, motor life on cranes is normally dependent on the amount of service in a short period of time, inasmuch as failure is due to temperature rises caused in turn by heat being produced faster than the motor can dissipate it. A relatively small number of cycles in which the temperature exceeds allowable limits will then reduce the overall life of the motor very appreciably. Consequently, "per cent time on in an operational hour" for a bridge is the information that is required to determine whether a motor is large enough to endure the service. For satisfactory service, a motor must have a rating such that the allowable per cent time on curve is greater than the per cent time on for the particular duty cycles involved. Since, in most crane service, the load is not constant, the watts-loss method is the best method in which this can be determined. Incidentally, the per cent time on data in series mill motor characteristic curves is based on five minute cycles. The "number of moves per hour" (Column 6) is also important in this determination inasmuch as the crane must accelerate for every move which means that it runs on the resistor during each move with a starting current which is greater than the normal operating current. Thus, in a case where two cranes have the same service, and both carry the same loads, if the bridge of one has to move 50 feet, this results in perhaps twice as many moves per hour as another crane which has to move 150 feet, although the per cent time on in an operational hour may be the same. The first crane, making the larger number of moves per hour, requires greater motor-heating capacity.

It should be emphasized that the information given in this table is average information which was collected and averaged from eleven steel plants' reports. Thus, in certain particular cases, actual values may vary rather widely from the figures given. In averaging the figures,

approximately six or seven out of about ten cranes as a general rule would be within five per cent of the final average. One or two would probably be a good deal higher, and one or two might be lower. In addition, for certain particular hours, a particular motion which might be in accord with the overall averages given in the table would have to do duty far in excess of that indicated. However, not all cranes were reported from each of the eleven steel plants surveyed, and in some cases where a particular type crane might not be in use in one of the plants, the information given may represent the experience of only one or two cranes. Such examples are relatively rare and most of the items in the table were reported from practically all of the plants.

Also, the information was not obtained from instrument studies but represents an estimate made by the engineer responsible for the maintenance and operation of the particular crane concerned.

Thus, this information represents a rational approach to what is required in order to design logically the various parts of the crane.

THE USE OF MULTIPLE BURNERS AND COMPRESSED AIR TO IMPROVE THE OPERATING RATES ON OPEN HEARTH FURNACES*

By V. F. CORSINI

Division Superintendent, Steel Works,

American Steel and Wire Company

Worcester, Massachusetts

▲ TESTS have indicated that the maximum fuel which could be burned efficiently in furnaces with 100-115 pounds steam pressure was 330 gallons of oil per hour and as the ends of their campaigns neared, furnaces became much slower. To obtain a shorter, sharper flame characteristic of relatively high steam pressures, a change in the distribution of the fuel stream was required and the use of two individual fuel burners was suggested on the basis that the 110-115 pounds steam pressure with lower fuel rates would greatly intensify the flame and at the same time the use of two fuel streams would permit much quicker mixing of fuel and incoming air to speed combustion.

The furnace started on dual firing August 23, 1946 and ran under these conditions until September 13, 1946, when it was shut down and the main roof replaced from knuckle to knuckle (192 heats from rebuild, 58 heats from cleanout, and 44 heats after starting double burners). Normally with single burners the roof shows initial wear at the corners and necks due to flame spreading around the piled scrap and burning late due to chilling. An entirely different condition exists when firing two burners. Even though there is more oil fired, combustion is much more rapid and the short, sharp flames appear to be reflected from the scrap to the roof. In addition, the top flame appears to hold down and spread the lower one, tending to make it approach the front and back skewbacks when reflected from the scrap.

Results of the initial test indicated an increase of 0.48 net tons per melting hour (5.1 per cent), 0.42 net tons per operating hour (4.8 per cent) and 1.54 gallons of oil per ton (4.4 per cent).

During January, 1947, a trial was begun on one of the furnaces which at that time was using only single burners. Compressed air was introduced underneath the lower burner. At the time of the installation the furnace was 112 heats from rebuild and ran for 68 additional heats using the compressed air. The results of the test showed an increase in tons per melting hour of 6.7 per cent, an increase in tons per operating hour of 7.0 per cent, and approximately the same fuel consumption. Actually, the considerable difference in favor of the compressed air, which is shown, does not represent as much difference as was realized, for the reason that the compressed air was not used until the latter part of the campaign.

The compressed air is started upon the start of charging and left on until the scrap is well melted down. Normal operations call for the use of 75-100 pounds per square inch of air which is equivalent to 275 cubic feet of air per minute at 100 pounds pressure. The arrangement of the burner is relatively simple, with the air being introduced through a 1-inch pipe positioned directly under the burner and the open end of the pipe flush with the burner face. The air pipe is water cooled and, to date, there has been no difficulty with its burning out.

Following the completion of the trial using single burners, compressed air was introduced beneath the lower burner of one of the double burner furnaces during the latter part of January, 1947. The production rate during this trial was extremely gratifying, with the result that all furnaces were completely equipped with compressed air and double burners by March, 1947, and a steady increase in production rate has been obtained.

The net effect over a full year has been an increase in production rate of 15 per cent over the best previous years, accompanied by a 4.0 per cent reduction in melting fuel. The figures for 1947 show a gain of 9.7 net tons per tap to tap hour and 4672 M net Btu per net ton of ingots based on 104 net tons per heat. At the present time, the improved production rates and fuel efficiency have actually reduced net wear of furnace brick through the burning of the fuel almost entirely on the hearth of the furnace. The increase in furnace pressure resulting from increased fuel input has also materially aided production rates and reduced fuel consumption.

*Condensation of paper presented before American Institute of Mining and Metallurgical Engineers, Pittsburgh, Pennsylvania, April 13, 1948

Lubrication Equipment Maintenance

. . . . automatic lubrication equipment is being used to an ever-increasing extent in the steel plant, and some plants have found it advisable to organize a lubrication repair and maintenance organization to obtain the maximum benefits from such equipment . . . .

By ROBERT A. KRAUS
General Millwright Foreman
Republic Steel Corporation
Chicago, Illinois

▲ IN this paper we are to be concerned primarily with the modern control and organizational methods currently being used or considered for obtaining correct lubrication and its related functions rather than with the more familiar what, where and how phase of lubrication. Endless material can be readily accumulated on the pros and cons of such items as the advantage of rust and oxidation inhibition for certain applications, of the advantages to be gained by using extreme pressure oils for certain other applications or the need for a high viscosity index in still other applications, but relatively little has been presented in a concrete fashion about good practice in those fields related and corollary to the field generally covered by the term lubrication.

We shall endeavor to embrace what has come to be known as the lubrication repair organization working out of a lubrication repair station, and investigate the influence that this group can have on overall maintenance and production costs. Similarly the relatively new concept of a bearing repair station will be reviewed and the savings that operators can realize by the reclamation and complete rehabilitation of work roll and backup roll bearing and chocks by this group will be demonstrated. Further, the advantages to management that are inherently available in the occupation of lubrication inspector, and the potential savings that can be realized by the skillful selection and use of this employee are to be reviewed. In addition, the improved control of general mill lubrication which is possible with the use of well prepared schedules in conjunction with lubrication inspector personnel and the mill oiler is to be considered.

The lubrication repair organization has been a necessary outgrowth of the predicament in which many mills found themselves some time after the installation of a number of automatic or semi-automatic lubrication systems on existing equipment. These systems were installed with the original thought in mind of providing considerably better lubrication for specific groups of machines than could be obtained by using only oiler personnel. Oilers frequently were unreliable and consequently those points requiring more effort to lubricate than the others were often neglected and at best, the frequency of even convenient points was erratic. Machines frequently had to be stopped to permit the oiler to perform his duties and as a result, vital production was lost.

Plant managers, engineers, and operators were highly desirous of maintaining high levels of production as well as eliminating the delay and expense of the repair work found necessary due to these neglected bearings and other wearing surfaces, and consequently various forms of centralized lubrication systems were in many cases introduced. After all, this was a device designed to greatly reduce lubrication man hours, to materially reduce the frequency of damaged gears and bearings which have burned out due to insufficient lubrication, to eliminate the common tendency of some operators to over lubricate the equipment, and further to permit the necessary lubrication of the equipment while the machine was in operation. These automatic and semi-automatic centralized systems provided immediate benefits to the operators which were found to be innumerable as compared to the previous methods of the hand grease gun and oil can. However, after varying periods of operation, it was also learned in many cases that unless a rigid inspection of these systems was maintained, the system could actually revert from an excellent asset to a liability. Crushed or broken lead lines or fittings presented the most serious threat to the continued fine performance of these newly installed systems, inasmuch as they frequently were not readily observed by the cursory inspection in most cases afforded the equipment by operators and production foremen. The result was damaged bearings, equipment shut down, lost production and repair expense, and in some cases complete loss of the confidence in the lubrication system which existed at its initial installation.

Many mills then resorted to some measure of inspection by millwright crews or by machine or pipe shop personnel. This represented a considerable improvement over the earlier condition, but in many cases still proved to be inadequate inasmuch as the frequency of inspection was erratic and usually insufficient. When broken tubing was found by these inspections, it could be readily repaired, but the more complex troubles, which at times occur from air bound systems, dirt in feeder valves and pumping equipment, etc., required some measure of skill to repair. Further, a very considerable knowledge of the mechanics of operation of the various types of systems was initially necessary in order to ascertain the exact difficulty which was being

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 25, 1947

Figure 1 — Shown here is a corner of the lubrication repair station which was set up to handle and maintain lubrication equipment in one portion of the plant.

experienced. Consequently these repairs were frequently beyond the ability of the most expert mechanic or millwright to perform unless he was specifically trained to the task. Just any good mechanic or millwright was not enough and further steps had to be taken.

Progressive management undertook as a trial a small organization to specifically maintain lubrication equipment in a section of one of our plants. The experience gained from this trial was so conclusive as to warrant the expansion of this organization, and further to encourage the initiation of similar groups in all other plants. In those plants where personnel existed with sufficient skill to repair these systems, the nucleus of the modern lubrication repair organizations as is now in operation was already available and progress was rapid.

The program was a natural outgrowth of the need for repair of a specialized type of equipment. Group leaders for the program were selected from outstanding mechanical men who had ability at pipe fitting and who were also adept at machine shop practice. To further their general knowledge of the various type of systems involved, these men frequently spent time at the factory of the equipment suppliers where the intricacies of the metering valves, pumping equipment, switches and alarms were investigated. The various forms in which the systems could be arranged were explained and their limitations were recognized and investigated.

After this training period, these personnel were capable of intelligently inspecting, trouble shooting where necessary, and repairing all types of lubrication systems and equipment. Because of their specialized training, these men became the natural group leaders supervising installation crews for installing new and expanding existing lubrication systems.

Where in many plants the first lubrication systems had proven to be a valuable asset and then later a source of annoyance and trouble, with a resulting reluctance on the part of management to proceed further with lubrication installations, the advent of the trained repair personnel proved to be the necessary key to the further and continued progress of lubrication modernization. Operators, who formerly had assumed that because a system was called automatic, also assumed it would provide adequate lubrication without attention for an indefinite time, and who were frequently disappointed when breakdowns occurred, had their confidence re-established by the service possible from these lubrication systems when service was coupled with intelligent inspection and efficient repair.

To promote the efficiency of this repair organization, progressive management has provided what has come to be known as lubrication repair stations as the bases from which these repair personnel work. Formerly conventional machine shop or millwright shop facilities were utilized, but the need for a common repair parts storage as well as the need for adequate inventories of tubing, fittings, etc., and the specialized tools frequently needed, dictated that a shop specifically for repair personnel be established.

The true value of such a repair station became readily apparent to management after the first of them had been constructed. Advantages that had been recognized before the construction of these stations were equalled by resulting developments that previously had been unforeseen.

Figures 1 and 2 indicate the first station of the type described that was completed within our organization. You will note that the station has been fitted with display cases showing the various lubricants in use throughout the plant, and also with cases displaying sealing devices, lubricating appliances, types of bearings and other lubricating equipment of mechanical interest. These displays have facilitated the holding of instruction classes at the station for groups of new employees of both the mechanical and electrical departments. These personnel now have the opportunity of being shown both correct and incorrect procedures in lubrication and the auxiliary fields through the medium of these classes. A measure of the interest shown in these classes is the quantity and quality of suggestions which are offered by the groups for field improvements as well as for improvements in the repair station facilities itself.

Figure 2 — Bins were set up displaying the various types of lubricating equipment and also small lubrication systems. Such displays were found very helpful in training lubrication men.

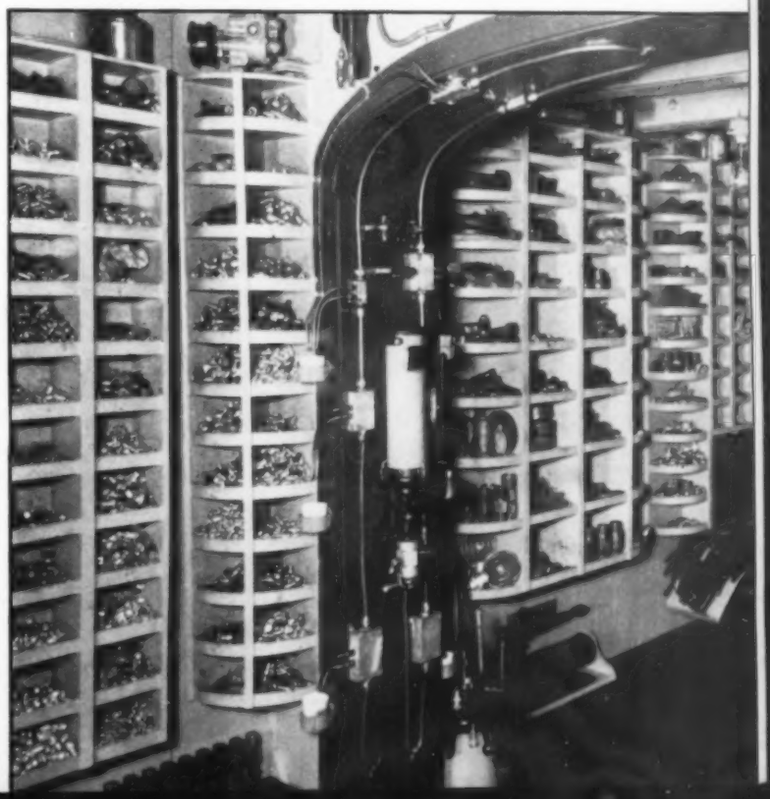


Figure 3 — Equipment shown was collected in a drive to recover inoperative equipment in the field.

In addition, it will be noted that small but complete semi-automatic lubricating systems have been installed in the shop for display purposes .These show the general construction details of a typical system, and are convenient tools for explaining to the lubricating classes the many ramifications possible with these systems. Cutaway and plastic valves are also displayed in conjunction with these systems to show the detailed functional operation of these valves while in service in the system. The effects of smashed lines or blocked feeders can in this way be more vividly demonstrated to the classes than would be possible without such systems and equipment.

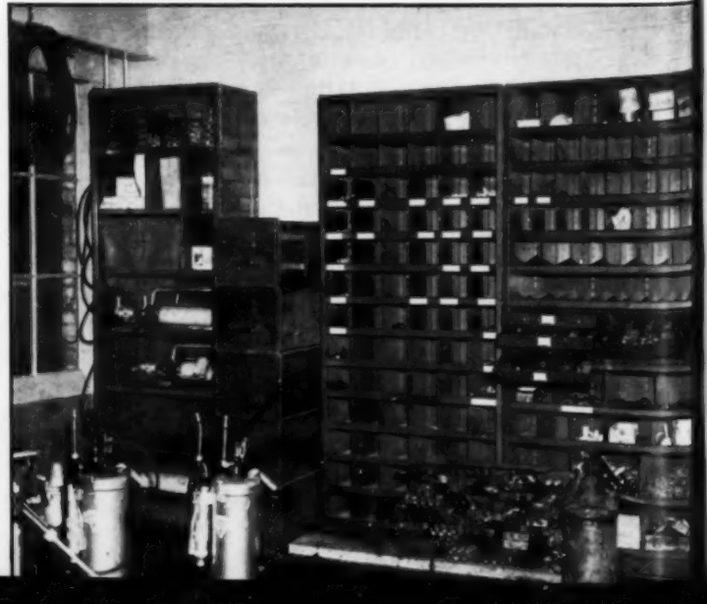
In addition to the repair facilities, parts storage facilities, and instructional opportunities possible with the lubrication repair station, the station has provided the means for complete standardization of lubricating equipment and many related items as well. For instance, instead of rather complete inventories of tubing fittings being maintained in anywhere from 6 to 20 localities throughout each of the various plants as formerly, with complete duplication of sizes frequently carried at each of these localities to cover the several styles of compression fittings, conventional and inverted flared types, etc., the repair station has now taken over the storage of these fittings and has standardized on one type only. Thus, for instance, if one of the districts has standardized on conventional flared fittings only, and tubing is damaged on equipment originally supplied with one of the other types of fittings, and if the fitting involved is not reuseable, the piece is repaired using only the conventional flared type. Thus the plant is gradually being converted to only one type of fitting, with the need for duplicate inventories already completely eliminated. These programs have been proceeding for some time with surprisingly few difficulties being encountered. Of course, all new equipment is being purchased wherever possible to conform to the established plant standard.

The mechanism for obtaining the necessary control of all items being standardized is to channel all purchasing of these items through the repair shop. Thus, if some department requires a grease gun, grease fittings or copper tubing or fittings, an air powered drum type pump or any one of a number of similar items, it is unnecessary to go through the trouble of requisitioning the desired item through the purchasing department. Simply sending someone to the lubrication repair shop for the desired item is sufficient. Here he receives the item desired, and the shop in turn may reorder to replenish its supply. In most cases the grease gun so obtained is not a new unit but rather is one of the standard design for the plant that has been rebuilt in the shop. Consequently repair parts rather than complete new units are frequently ordered. A secondary gain accrues to the company by this process inasmuch as a large number of individual requisitions need not be processed through the entire purchasing channels to obtain the various items, but instead a single request is frequently processed. When the repair shop orders to replenish its supply, the requisition may cover a dozen or more individual requests. Needless to say, the long wait for the operator between placing his purchase request and actually receiving the material is virtually eliminated by the small but rotating stock at the repair shop.

This method has a further gain in that when consumption of some item increases in a particular locality, the effect is immediately noted at the repair shop and steps to correct the cause for the breakage, etc., can be readily initiated by the repair organization. These standardization procedures are progressing with a minimum of difficulty due primarily to the convenience and service offered by the organization and the shop.

As indicated previously, the inventory of the plant's total lubricating equipment is continually rotating. As units are rendered inoperative in the field, they are returned to the shop for service and repair, and a rebuilt unit is sent out in its place. In most cases, the savings affected by the reclamation phase alone of the shop activities has completely underwritten the first years expense of construction and operation. Figure 3 indicates a typical condition encountered during the initial drive to recover all inoperative equipment in the field during the early days of a lubrication repair station. Obviously the equipment is complete with the exception of some minor parts. After cleaning, replacement or repair of the damaged parts and paintings, the great

Figure 4 — Equipment is brought to the shop on an exchange basis, and since the equipment is repaired in the meantime, it is not necessary to maintain a large inventory.



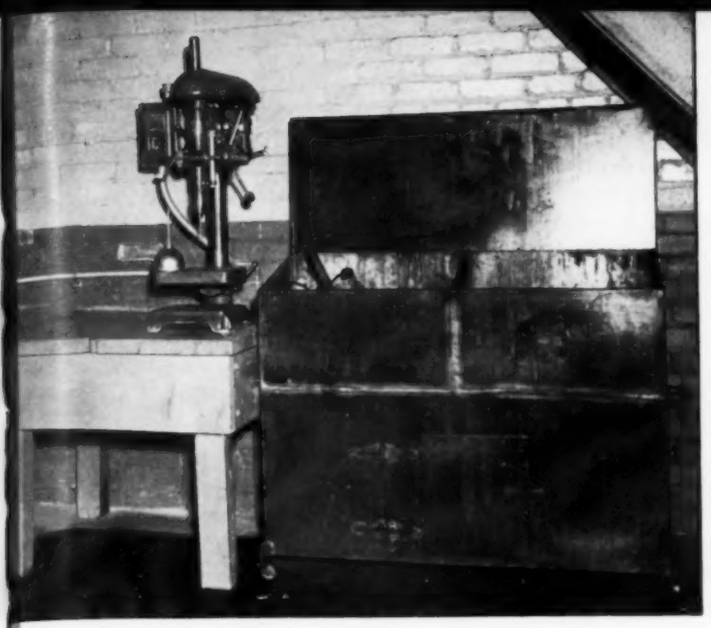


Figure 5 — Shop locations are set up near existing solvent degreasers.

majority of this equipment was completely reuseable.

Figure 4 indicates a similar group of equipment that has been returned to a shop for repairs. The constant repair and rehabilitation of this equipment makes a large inventory of spare equipment unnecessary inasmuch as most units are brought to the shop on an exchange basis.

In many cases the repair stations which initially started with only lubrication equipment repair, have extended their activities to include hydraulic valves, equipment coolant systems, strainers and pumps, circulatory pumps, gages of all types, and many other specialized items requiring repair. Where considerable territory has to be covered, a modification of the repair station has been employed as a mobile unit. Other plants have branch shops at strategic locations where the need is evidenced. However, in all cases, the orderly and clean shop, coupled with the stress on standardization and good equipment repair, has fostered the growth of good lubrication practice with considerable benefit gained thereby.

Shop locations are usually near where existing solvent degreasers are employed since a considerable portion of the repair cycle is the cleaning of the equipment. Solvent degreaser type of cleaning is highly desirable for this work, but where suitable units were not available, home fabricated cleaning tanks have been employed with success. These should be fitted with a spray pump, and should have at least two compartments for best operation (Figure 5).

Figure 6 illustrates some of the tests to which all repaired units are subjected prior to being placed in the available inventory. It has been found to be good practice to test all equipment after repair to prevent unsatisfactory equipment from reaching the field. In this case, the shop standard pressure gage, mounted on the wall is checking the pressure gage on the equipment while the equipment is being tested for output.

After equipment is repaired, it is scheduled for shipment to operating departments. Records kept of repairs frequently show the need for relocation of field equipment to prevent reoccurring damage, or show the need for further instruction to operating personnel in the handling of equipment.

Those districts in our corporation where strip mills are located have for the greater part an organization known as a bearing repair crew operating out of a bearing repair station. Inasmuch as the dollar value of the bearing replacements in a modern strip mill reach a tremendous figure, the savings possible from the services of this group in the rehabilitation of work roll and back-up roll bearings also reaches a sizable figure.

The chief functions of this organization are to continually check and repair the back-up and work roll bearings of both anti-friction and oil film type bearings, as well as some other large bearing installations throughout the district, and to keep adequate records of each bearing in which the group is interested so that inspection intervals, bearing conditions and life expectancies may be determined. Obviously, this is preventive maintenance at its best.

All work roll and back-up roll bearings and chocks are returned to the repair shop at least once each six months for a complete inspection. For anti-friction bearings, this inspection involves all bearing tolerances, condition of race way and roller surfaces, and the condition of retainers, spacers, and seals. Special attention is given immediately to all bearings involved in mill wrecks, broken rolls, etc.

A complete history is maintained on a card record for

Figure 6 — Repaired units are subjected to tests prior to being made available for operation.

Figure 7 — This photograph shows a dirty bearing from the mill, which has been opened, ready for cleaning.

both new and reconditioned bearings, including the nature of all repairs performed, the accumulated tonnages, and the extent of time in various mill locations. A study of these records has frequently revealed the need for mechanical changes in mill equipment which were virtually impossible to obtain in any other manner.

Figure 7 illustrates a back-up bearing as received from the mill after being removed from the chock and opened prior to cleaning. Figure 8 shows a cone and roller assembly being removed from the cleaning tank. Figure 9 indicates how a spalled spot on the cone was made accessible for grinding after removal, in this case, of one roller. The rollers and cup assemblies are subsequently carefully inspected and all spalled spots are ground in such a manner as to eliminate all sharp openings or fissures. Where these sharp edges have been properly ground off, a definite lessening of the rate of enlargement of the opening has been noted during subsequent inspections.

The equipment required for the proper inspection of these bearings consists essentially of a surface plate table, leveling table for clamping and gaging bearings, a steam heated oil bath and drain table for bearing cleaning, and necessary storage bins for bearing rollers, gaskets, oil seals, spacers and other miscellaneous items. In addition to such hand tools as hand grinders, suitable micrometers, and surface gages, etc., it was found advisable to provide a powered barrel pump for loading bearings with grease before sending them to the mill. This practice was considered essential for good operation at start up, with additional makeup grease handled in service from the mill automatic lubrication system.

Figure 10 illustrates a reconditioned bearing under a seating load being measured to get proper clearance with adjusted spacers. It is felt that maximum bearing service life can only be obtained where accurate tolerances have been established prior to being subjected to service conditions. As a means of minimizing confusion surrounding the regrinding of more than one spacer at a time, a numerical coding system has been established giving the exact finished dimension involved.

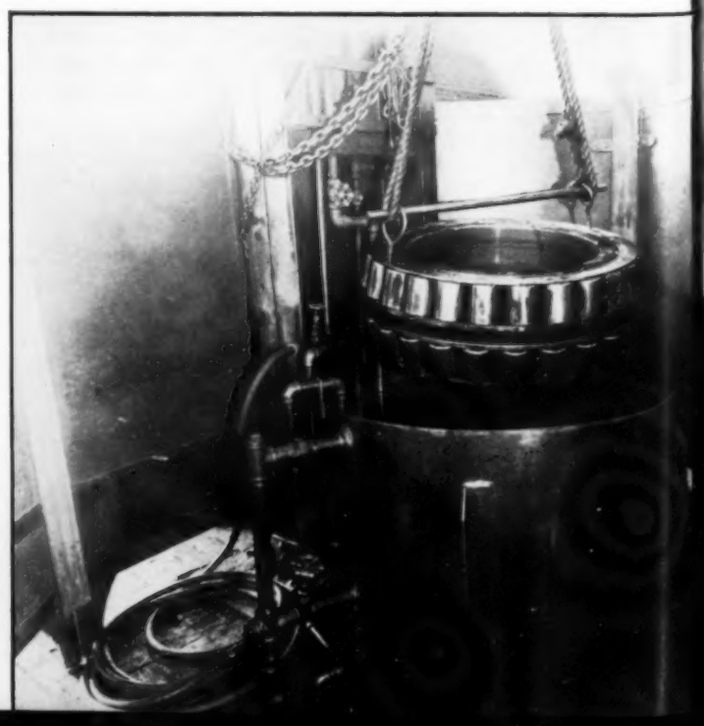
Figure 11 shows a full assembled and polished bearing being readied for shipment back to the mill. Usage of a rust-proofing compound at this time decreases the possibility of corrosion of the metal surfaces during the period between repair and actual service.

A similar inspection program has been instituted for oil film type strip mill bearings. Since distortion of the metallic surface during service can frequently disturb the proper distribution of oil from the oil wedge pocket with ultimate resultant metal to metal seizure and complete destruction of the bearing surface, a routine inspection and rehabilitation based on mill conditions has paid dividends. Here again accurate records dictate inspection intervals.

Considerable stress has been laid upon adequate scheduling and inspection in the preceding discussion. Bearings are scheduled out of the mill based on data obtained from their record. Scheduled inspections of lubricating systems determine the need for repairs by the lubrication repair organization. Inspection of bearings by the bearing repair group is the basis for the savings which justify their existence. After analysis, it becomes obvious that for close control over any orderly process, schedule and inspection are the keys that maintain the process orderly.

With this in mind it is suggested that adequate scheduling and inspection properly carried out, may be the answer to the problem presented by continuously operated machinery with its need for adequate lubrication to maintain production. It is true that automatic and semi-automatic lubricating systems have gone far in reducing maintenance, but even on these machines, there frequently are points that could not be included in the system for mechanical reasons, and there are oil reservoirs for gears, chains, drives, etc., as well as other devices requiring manual attention. In some cases these duties are left to the attention of the operating depart-

Figure 8 — Shown here is a cone and roller assembly which is being removed from the cleaning tank.



ment for service. In other cases millwright crews attend to it in their spare time. However, both approaches invariably prove unsatisfactory in the long run when a gear reducer or a bearing reach an untimely end.

Inspection and lubrication of such equipment is best left to someone who can be held fully accountable for the ensuing condition. If this is not done, the negligent party is seldom apprehended since most equipment will get by without lubrication for several days, or perhaps much longer in some cases, before the final breakdown occurs. And in these instances, we are all familiar with the fact that it was invariably considered the fault of the fellow on the night turn. Conditions of this type are common in the experience of all maintenance and administrative personnel.

As a result of this type of unfavorable and costly experience, work of this nature should be allocated to specific lubrication inspectors and the responsibility is then fixed. This fixing of responsibility, when coupled with the proper type lubrication survey to guide the oiler in the routine performance of his duties, has proven to represent the most effectual and all inclusive coverage found to date.

These surveys take the form of a plan view of the roll train and other mill equipment. A notation is made at each specific unit covering the number of points to be lubricated at that unit, the number of gear sets involved, the frequency of lubrication application and the nature of the lubricant, and other pertinent data. This type of plan schedule is not completely new in concept, but the method of initial layout may be new. Schedules of this type are made only after consideration of the results of an industrial engineering study involving time elements for performing the actual lubrication act, the walking time to get the necessary products, the availability of products, delays in setting up equipment, etc.

Interesting conditions are inevitably brought to light during these workups. Considerable lost productive time is frequently found by having the hand grease gun or oil can lubricant supply become exhausted at a considerable distance from the bulk storage. This inevitably caused some bearings to go unlubricated or resulted in very extensive lost productive motion while the grease gun was being returned to the oil house to be reloaded. Relocated oil houses in some cases saved many minutes of walking time. In other cases, auxiliary depots located at more convenient localities were the answer. Frequently the time interval found necessary to lubricate specific equipment by the old hand method

Figure 9 — By removing one roller, it was possible to obtain access to a spalled spot on the cone so that it could be ground.

Figure 10 — Bearings are measured under a seating load in order to obtain proper clearance with adjusted spacers.

showed that automatic systems were readily justified by the study. Other cases of inefficient mechanical design were highlighted to an extent to warrant alteration.

In all cases very considerable portions of time were found to be wasted and corrective measures were taken. In summary, the survey when properly made permitted more area to be covered adequately and correctly by one oiler than had been done previously, and usually the quality of the lubrication obtained was improved.

To maintain the schedules in proper working order, to maintain the quality of the lubrication performed by the oilers, and to watch the supply of lubricant in automatic systems, in gear reservoirs, etc., the lubrication inspector fits into the picture very well. The duties of this occupation are the continued and reoccuring inspection of all equipment in his area of the plant. This usually covers a number of rolling mills or similar departments and includes all related and auxiliary equipment in the vicinity.

His inspection is designed to cover all mechanical equipment and includes a search for loose bolts, noisy bearings or gear reducers, worn bearings, and linkages, obvious gear or bearing misalinement, excessive temperatures in operating equipment, damaged pipe or tubing in lubrication systems or other equipment, leaking packings, etc. The early location of many of the above difficulties may prevent a serious breakdown from occurring with subsequent lost production as well as repair expense.

Obviously the caliber of the man necessary to perform a quality job such as has been described is commensurate to a top flight millwright or group leader. The training as realized on a job of this nature further fits these men for ultimate advancement into more responsible positions.

In addition to the general mill inspections, these personnel are usually entrusted with maintaining watch over certain other related tasks such as the mill spares rust proofing program, etc.

In general, the returns from the aforementioned pro-

Figure 11 — After polishing and assembling, bearings are boxed, ready for shipment to the mill. The use of a rust proof compound reduces possibility of corrosion during shipment.

grams more than offset the liabilities incurred. Savings from decreased mill delays which include equipment repair expense, idle mill crew expense and lost profit, when added to the savings obtained by decreased circulating oil system losses, increased reclamation, and general improved lubrication practice will more than offset the small expense incurred in maintaining the inspection program in operation.

In conclusion it should be pointed out that while the various phases of the subject have been discussed in a somewhat individual manner a certain degree of interrelationship does exist which in the overall picture leads to an improved condition of equipment conducive to better costs and more continuous production.

DISCUSSION

PRESENTED BY

A. J. JENNINGS, General Sales Manager, Farval Corporation, Cleveland, Ohio

R. A. KRAUS, General Millwright Foreman, Republic Steel Corporation, Chicago, Illinois

FRANK D. JOHNSON, Vice President, Trabon Engineering Corporation, Cleveland, Ohio

C. T. LEWIS, Lubrication Engineer, Republic Steel Corporation, Warren, Ohio

R. S. SHOEMAKER, District Manager, Brooks Oil Company, Middletown, Ohio

A. J. Jennings: Mr. Kraus has covered the development of an organized lubricating equipment maintenance department, its duties and the end result of its effort so fully that I find it difficult to offer constructive criticism or add to the thorough job being done by his company. However, some thoughts have occurred to me that may at least serve to further emphasize the value of a well organized lubricating equipment repair department.

From the standpoint of the lubricating equipment manufacturer proper maintenance of the centralized systems is one of the vital steps to insure that the user will get the maximum benefit from the investment he has made in this modern tool to keep the steel rolling.

I was impressed with the outline of the display cases covering bearings, seals, and lubricating devices, and including complete operating systems with both plastic and cutaway models. Other companies have also found these display panels invaluable from the standpoint of instructing and educating their lubricating equipment installation and repair men in the mechanical details of the systems. He also touched on the fact that their men frequently visit the plant of the lubricating equipment manufacturer to gain a first hand and more thorough knowledge of the essential elements of the lubricating system. There is no question as to the value of such visits because the men can get more real data on the proper operation, the proper care and how to make repairs, than they can obtain from any other source. Our company maintains a combination experimental and test room where every detail of the system can be examined and their operation observed. Frankly, we feel we have had too few visits from the lubricating engineers, inspectors, or repair men, in fact, we have considered putting into effect a plan whereby one of our service men would be constantly contacting the lubrication inspectors in the mills for the purpose of teaching them how to inspect, record data, and effect repairs on the job.

The inspection data record on each of the lubricating systems should cover the correct operating pressures and the time required to complete one cycle of operation in addition to the system piping, bearing connections, etc. By filing and rechecking this record at periodic intervals, any change in operating conditions can readily be checked for cause and effect.

I would also point out that one way to prevent damage to a lubricating system is to use more care in its original installation. We believe the lubricating engineer should have a voice in the selection of the original equipment and that it would pay dividends if he were to visit the plant of the machinery builder and make certain the design will provide a dependable installation, without a lot of extra work in the field.

Mr. Kraus has pointed out that centralized lubricating systems protect the investment made in the mills, tables, cranes, and all other major mill machinery by preventing shutdowns and delays through lack of lubrication, and further that the proper maintenance of the lubricating equipment is very much worthwhile. He has also shown very clearly, I feel, that it pays dividends to train the men to take proper care of better lubricating equipment. The results obtained by his company through their progressive lubricating equipment maintenance program, proves that such a program properly supported by management, is worthwhile for any company.

These trained lubricating equipment maintenance men unquestionably are a valuable asset of the steel industry and it would seem to be sound economy to perhaps raise the standard of these jobs and avoid the

hazard of either losing a good man or being obliged to promote him out of the department, only to start all over again.

Member: In the early part of the paper Mr. Kraus commented pertaining to unreliable oiler personnel. It is my opinion that the days of the so-called oiler are numbered. I make this statement because of the fact that most modern mills today are equipped with automatic or semi-automatic lubricating systems, and furthermore, it is the ambition of every lubricating engineer, or whoever may be in charge of lubrication, to install this type of system wherever possible. It is rather convenient when one can walk into a large mill and gaze upon a few panel boards that tell the entire story. This is actually possible if you are gifted with the type of personnel Mr. Kraus spoke of in his paper. Does the company for whom you work employ a lubricating engineer?

R. A. Kraus: Yes.

Member: Does he have an active part in the repair organization, and if so, what are his duties?

R. A. Kraus: The lubrication engineer is responsible for the direction and operation of the repair shop. It is under his direct jurisdiction.

Member: Do the repair shops work around the clock?

R. A. Kraus: No, it is generally a day turn occupation.

Member: Would you give us some idea as to the possibilities of advancement for a newly hired employee, that is, one who comes into this lubrication organization?

R. A. Kraus: Initially, it should be pointed out that only higher caliber personnel are desired. At the beginning of his training he would perhaps be assigned to the shop for the repair of the more simple equipment such as grease guns and for the cleaning and painting of equipment. Then as he became more familiar with the equipment he would be advanced to the repair of the more complicated units, such as electric and air powered equipment and the automatic cycle pumps. If the man continues to show promise, he would be put in charge of new field installations or alterations of existing lubrication systems. From here the line of advancement could possibly be into maintenance inspector or managerial positions depending obviously upon the caliber of personnel involved.

Member: What is your opinion regarding the proper level of wages for men hired as maintenance personnel, commonly known as grease monkeys? In other words, are there incentives to attract better than average men for jobs in these shops that you have discussed?

R. A. Kraus: Unfortunately, the wage scale for the oiler is high enough to attract only oiler personnel, nothing more. The inspectors are of course paid considerably more than just oilers with a rate near or above top millwright rate. The lubrication repair man is paid a rate commensurate with other skilled craftsmen, and the lubrication repair man's helper is paid similar to other craftsmen's helpers.

Member: Would the organization you speak of tolerate an inspector or lubrication repair man doing millwright work?

R. A. Kraus: This is something that must be stopped early in the program. Otherwise the inspector will become nothing more than a glorified millwright. The lubrication repair man is not generally exposed to this sort of request for assistance in general mill repairs inasmuch as he works out of a separate department with different supervision.

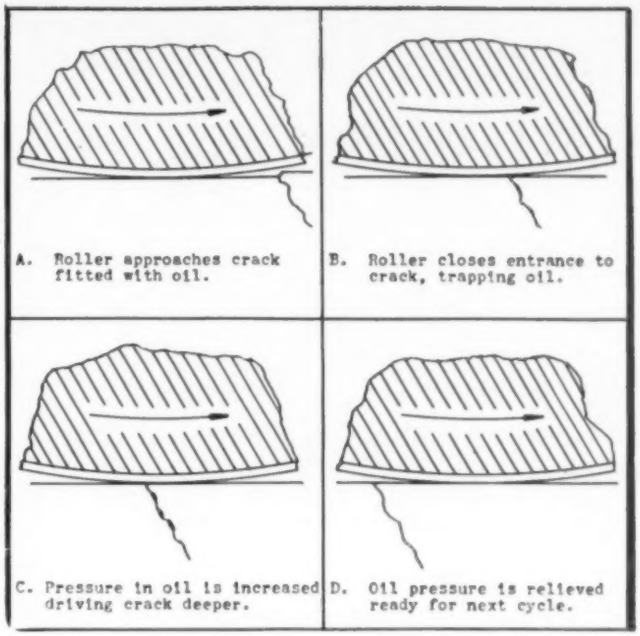

A. Roller approaches crack fitted with oil.
B. Roller closes entrance to crack, trapping oil.
C. Pressure in oil is increased driving crack deeper.
D. Oil pressure is relieved ready for next cycle.

Figure 12 — This sketch illustrates the steps by which oil is driven into a crack in a bearing under rolling contact with the resultant oil pressure enlarging the crack and driving it deeper.

Member: Who in this organization is responsible for replenishment of spare parts consumed?

R. A. Kraus: The man who is stationed in the shop to do the repair work. He keeps a check on his inventory as he uses parts in repairing equipment.

Member: In your paper you mentioned that when repairing bearings in the bearing repair shop, the proper grinding of existing bad spots or fissures reduces or eliminates growth of these areas. Why is this?

R. A. Kraus: That can be explained, at least in part, by reference to what is sometimes known as the Stewart Way theory of pitting. Dr. Way of Westinghouse Research Laboratories investigated the causes for the development of pits in gear tooth surfaces and other parts which operate in rolling contact. His conclusions after considerable investigation indicated that the pits started with cracks which had previously developed from heat treatment, grinding, fatigue or other causes. These pits were preferentially extended by the action of the lubricating oil.

If Figure 12A shows a section of the inner race of a roller bearing and contains a crack inclined as indicated, pitting will develop in the following manner: The roller approaches the crack which is filled with lubricant and finally closes over the entrance to the crack trapping a small quantity of the lubricant as indicated in Figure 12B. In progressing further, the full load is imposed on the crack, developing extremely high hydrostatic pressures in the entrapped oil. This causes a hydraulic jacking action which tends to drive the crack deeper into the material, which ultimately results after many cycles in a sizable piece breaking out through a combination of this action and fatigue.

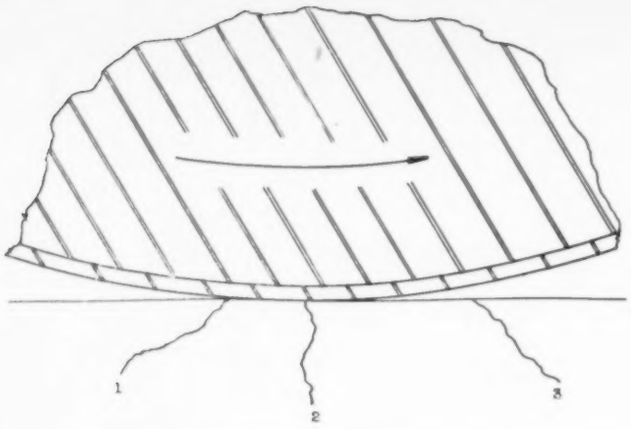


Figure 13 — Only the cracks which are inclined in the direction of rolling will develop pits, and in these cracks only is the oil driven by the rolling pressure.

Proof of this hypothesis has been offered by first rolling surfaces together for a very large number of cycles without any lubricant present. The initial grinding and subsequent surface fatigue cracks are undoubtedly present but no pitting develops. However, shortly after oil is added to the system, pitting begins to develop.

It is obvious that only cracks inclined in the direction of rolling can develop into pits since cracks, Figure 13, straight down as No. 2 or inclined in the reverse direction (No. 1) will not grow under this action. Crack No. 3 is correctly oriented and consequently will grow. Proof here is offered by rolling a system in a given direction until pitting starts and further fitting will continue with continued rolling. If the system is then reversed and rolled in the opposite direction, further pitting will stop until the approximate number of cycles necessary to start pitting in the original direction has been reached; and then pitting will continue as previously. This is due to the length of time required to advance the cracks inclined in the reverse direction to the stage of pitting.

Obviously this development work applies equally well to gear surfaces as well as roller races since gear teeth operate under rolling contact.

Frank D. Johnson: We all know that for years industry has accepted bearing failures as a necessary evil, with no way to correct it. But now a few plants are developing the organization who will devote their entire time to the inspection and maintenance of bearings, including the lubricants and lubricating systems.

An inspection and maintenance department for all phases of lubrication and bearings has become an absolute necessity in a steel mill if the full benefits are to be obtained. Maintenance costs are high for keeping the mill machinery running, and I know that the organizational methods as outlined by Mr. Kraus will pay big dividends. I have sat in at meetings this year at three different plants where they were setting up such an organization. At each place they had been convinced that they needed an experienced crew to constantly inspect and maintain their lubricating systems. They finally realized that it was necessary to have a good man to supervise such a department and have good men under him to help with this work.

The training program was the same as that outlined by Mr. Kraus. They also set up a program of pay so that they could keep a man on this work and not lose him to some other department. This all signifies the trend which this work is following today.

C. T. Lewis: I have nothing additional to offer as far as lubrication repair stations or lubrication maintenance repair are concerned. However, there are two points I should like to stress. As far as bearing repairs are concerned, there seems to be some point of discussion as to bearing clearances, particularly in antifriction types, and the repair of these antifriction bearings to minimize failure. As has been illustrated, I can definitely confirm the statement that by changing the direction of rotation of an individual roller on a cone after having ground the given pit out, it will take quite a period of service operation before the progressive growth of that spalled area will start over again. This bears out the fact that the pitting reaction is only in one direction due to the hydrostatic pressure developed by the oils being entrapped in a given fissure in the metal surface.

As far as tolerances are concerned, our experience has proven that if we increase the lateral end play on most of our mill bearings, we get considerably better life. It may be due entirely to mill housing fits or possible misalinements which very readily develop as the faces of the chuck and windows wear. However, experience has proven that by even doubling the lateral end play in some cases, we have been able to obtain quite an increase in tonnage record.

The strange part as far as repairing some of these bearings is concerned, is that we have found by assembling, say, a 4-row type antifriction bearing, taking cones from one or two bearings that have failed, a double cup from another, and a single cup from each of two additional bearings, and by reassembling all these parts from four or five bearings in the beginning and setting up proper spacings on it, we have obtained an average tonnage on the repaired or rebuilt bearing approximating that expected from a new bearing.

All of which goes to stress the advisability of the repair station installation, in conjunction with or closely associated with your normally established machine shops. We find that it pays dividends.

R. S. Shoemaker: I have one question. You say after you have ground the pit, it is a long time before you have additional movement or enlarging of the crack. Why is that? Is the flow of the metal and the notch effect coming back into effect?

C. T. Lewis: From all appearances, I would say yes. In other words, I state that in view of the fact that we have taken some bearings out, finding spalled spots, say, on a cup, which is in most cases the first point of failure, and the spalled spots have the lines very plainly visible to the naked eye, with the fracture all traveling in one direction, that is, while the spall is fairly small. If the bearing misses out at inspection time and goes too far, then the cracks will again return to the surface, but if you can catch it, the cracks in a lot of cases are definitely in one direction. By grinding those out completely, reversing that cup in the mill, that is, as far as direction of rotation goes, it will again take quite a long period to develop further cracks, but they must be ground out perfectly.

BEARING CONSTRUCTION AND PERFORMANCE CHARACTERISTICS

. . . . surprising as it may seem, bearing life usually goes up as the thickness of the bearing material decreases . . . . thin shell bearings have now been universally adopted in the automotive field and this trend now is evident in the heavy machinery industry . . . .

By E. CRANKSHAW, Assistant Chief Engineer and
K. SCHEUCHER, Assistant Chief Product Engineer
Cleveland Graphite Bronze Company
Cleveland, Ohio

▲ In the usual discussion of bearing performance characteristics, reference is made to several criteria such as fatigue strength, surface action, corrosion resistance, imbeddability, conformability, and mechanical strength. In beginning this discussion, it is perhaps wise to establish tin base babbitt as a base for comparing bearing performance of the various bearing alloys and bearing constructions.

Tin base babbitt along with the lead base white metals is accepted quite generally as the preferred bearing material within its range of load carrying capacity.

In the evaluation of any bearing problem, it is realized that sufficient fatigue strength must first be provided to give the required life for a particular operating and loading condition. Unit bearing loads in various machines and engines have risen sharply as a result of the increased horsepower output for a given size machine, making it necessary to produce bearing materials and constructions with substantially greater load carrying capacity for those applications where the lower fatigue strength of 0.013 in. and greater thickness of bearing material proves inadequate.

In making this statement, it is well to say that a greater thickness of bearing material than $\frac{1}{32}$ in. is rarely specified in present-day designs. This practice has eliminated the possibility of plastic flow and the resulting failure, which is attributed to the excessive running clearances thus produced, and subsequent oil film failure. Economics have also played an important part in this decision as material costs have been reduced by adopting this improved design.

Bronze, copper-lead, leaded bronze, cadmium nickel, cadmium silver, and aluminum all have greater fatigue strength than the lead and tin base white metals.

Although fatigue strength is increased substantially with the use of copper-lead, surface quality was sacrificed somewhat even though the lead content is maintained at a relatively high level. To further improve the surface action and to provide for more distortion, such as may be encountered in many mechanical devices, a thin surface layer of babbitt is provided on a leaded bronze intermediate layer. Through the use of controlled thinness of the surface layer and the use of a high strength intermediate, an increased fatigue life is obtained over that of conventional babbitt, although not as great as some copper-lead type bearings. In addition, complete protection against corrosion is obtained even where adverse conditions are encountered.

The considerable improvement in fatigue life to be gained by the use of thinner white metal layers has been well demonstrated experimentally as well as by vast field experience. A typical "Life vs Thickness" curve is shown in Figure 1.

It will be noted that in the thickness range of 0.014-0.032 in., the lining thickness has no effect on the bearing life. In the critical zone where the thickness varies from 0.005 to 0.014 in., there is a very noticeable increase in bearing life, but the ultimate is reached in the 0.001 to 0.005 in. range.

For the great majority of smaller journals (5 in. shaft and under) the greater strength, where required, is pro-

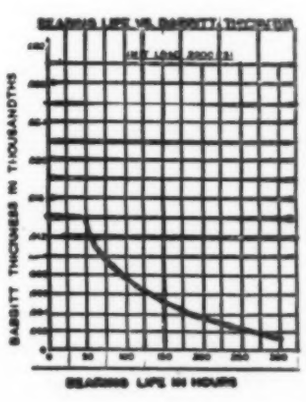


Figure 1 — The curve shows the improvement in fatigue life which may be obtained by the use of thinner bearing metal layers.

Presented before AISE Annual Spring Conference, Philadelphia, Pennsylvania, May 26, 1947.

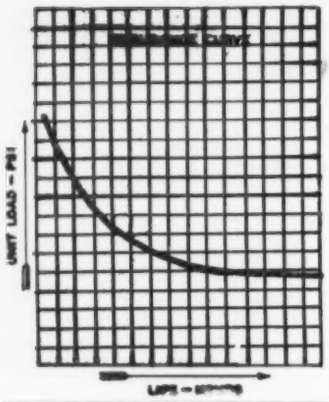


Figure 2 — This curve gives the load-life relationship of a typical bearing material.

vided by the use of thinner white metal layers directly on steel backing, since the alinement and distortion conditions of these units is usually good.

Where increased horsepower outputs of new designs have presented greatly increased unit bearing loads, it is realized that the above described materials and constructions are inadequate for provision of satisfactory life. This has resulted in a modification of the trimetal construction where the surface layer in new thickness (0.001 in. ± 0.0001 in.) is commercially obtainable through precision plating of a lead-base alloy. An excellent running surface is thus provided with a fatigue strength so great, due to its uniform thickness, that failure of overlay by fatigue no longer is the limiting factor. If this overlay should finally disappear, a copper-lead alloy layer, which is a distinct improvement over the other intermediate layers, is provided. Development of this alloy and its production casting methods has provided a high fatigue strength intermediate layer as well as a good running surface. Conformance properties of this composite bearing are good since much of the operating distortion is accommodated by the overlay before the intermediate layer actually is exposed.

Extensive experience has proved that use of proper construction is provided by means of modifying our base line (0.020 in. babbitt) bearing to meet the increasing demands of modern bearings. While on the general subject of construction, it should be noted that steel backs are used almost universally because of the advantages which they offer in increased installation stability, higher fatigue strength, less brittle bonding, and lower overall cost.

Where aluminum alloy bearings are desired, they are furnished in solid construction. Wall thicknesses less

Figure 3 — These charts show the relative load carrying capacity of a number of different types of bearing materials.

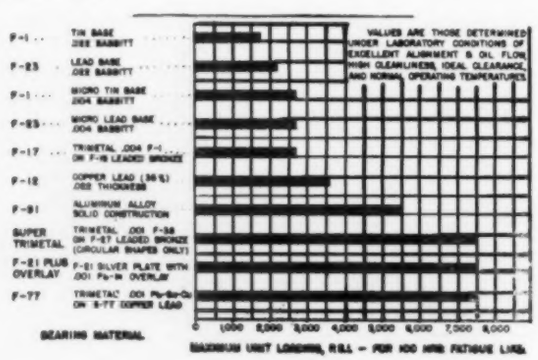
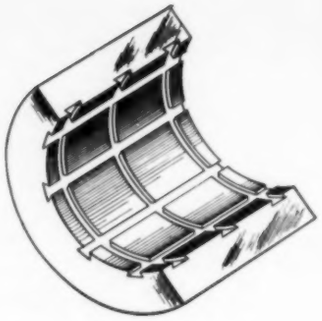

VALUES ARE THOSE DETERMINED UNDER LABORATORY CONDITIONS OF EXCELLENT ALINEMENT & OIL FLOW, HIGH CLEANLINESS, IDEAL CLEARANCE, AND NORMAL OPERATING TEMPERATURES
F-1 ... TIN BASE .022 BABBITT
F-23 ... LEAD BASE .022 BABBITT
F-1 ... MICRO TIN BASE .004 BABBITT
F-23 ... MICRO LEAD BASE .004 BABBITT
F-17 ... TRIMETAL .004 F-1 ON F-16 LEADED BRONZE
F-12 COPPER LEAD (30%) .022 THICKNESS
F-21 ALUMINUM ALLOY SOLID CONSTRUCTION
SUPER TRIMETAL TRIMETAL .001 F-38 ON F-27 LEADED BRONZE (CIRCULAR SHAPES ONLY)
F-21 PLUS OVERLAY F-21 SILVER PLATE WITH .001 Pb-In OVERLAY
F-77 TRIMETAL .001 Pb-Sn-Cu ON F-77 COPPER LEAD
BEARING MATERIAL
0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000

Figure 4 — Thick backing used to be specified in order to obtain the dovetails for locking the bearing material.



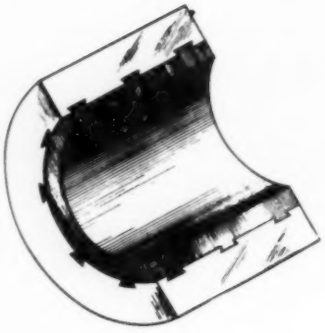


Figure 5 — Shown is a heavy babbitt bearing after being bonded into the backing shown in Figure 4.

TABLE I

Relative Characteristics of Various Bearing Materials

(Tabulated in order of decreasing values)

Fatigue resistance	Surface Behavior	Corrosion
F-77 with 0.001 in. overlay	Tin base (bimetal or trimetal)	Tin base (bimetal or trimetal)
Leaded bronze with 0.001 in. overlay cast or plated	Lead base (bimetal or trimetal	Aluminum alloy silver
Silver with 0.001 in. overlay	Cadmium	Lead base (bimetal or trimetal)
Lead bronze (bare)	Aluminum	S-77 (bare)
Aluminum alloy	Copper lead (F-12)	Leaded bronze
Copper-lead (F-12)	S-77 (bare)	Cadmium alloys
Lead base micro (0.004 in. thick)	Leaded bronze	Copper-lead
Tin base micro (0.004 in. thick)	Silver (bare)	
Tin base trimetal (0.004 in. surface layer)		
Cadmium alloys		
Lead base alloys		
Tin base alloys		

Except where otherwise noted, lining thickness is 0.022 in. for bimetals and 0.014 in. for trimetal intermediate layers. Aluminum alloy is solid construction.

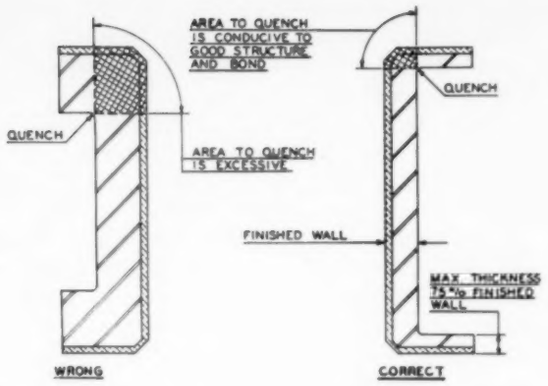


Figure 6 — Desirable proportions of bearing in order to give the proper quench are illustrated in this sketch.

than 1/8 in. are not recommended for this material, so its use is generally restricted to the larger engines.

From the foregoing we have obtained a general concept of various constructions and the purposes which they serve. A summary of their relative characteristics is indicated in Table 1.

The actual selection of material and construction is dependent upon many factors, including operating loads, installation factors such as alinement and distortion, operating conditions such as temperature, dust and vapors, service factors, fuels and lubricants, and certainly upon life expectancy. For instance, in obtaining utmost reliability for aviation units, short term rebuilds are made with earlier replacement of vital parts. In other cases, some stationary engines are expected to run continuously for several years under conservative operating and servicing conditions. It is recognized that longer bearing life is obtained by reduction of loading. The general nature of this load-life relation is depicted by the endurance curve shown in Figure 2.

To definitely establish permissible bearing loading values for various applications is an impossible task

Figure 7 — Shown in this photograph (magnification 20X) is a typical structure resulting in a standard lead base centrifugal casting operation. The photograph shows the lining thickness as cast and the proportions below the lining shows the "f" lining thickness.

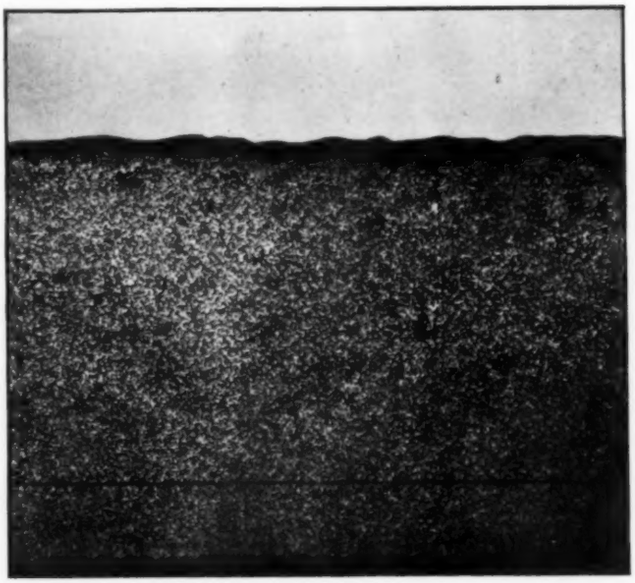


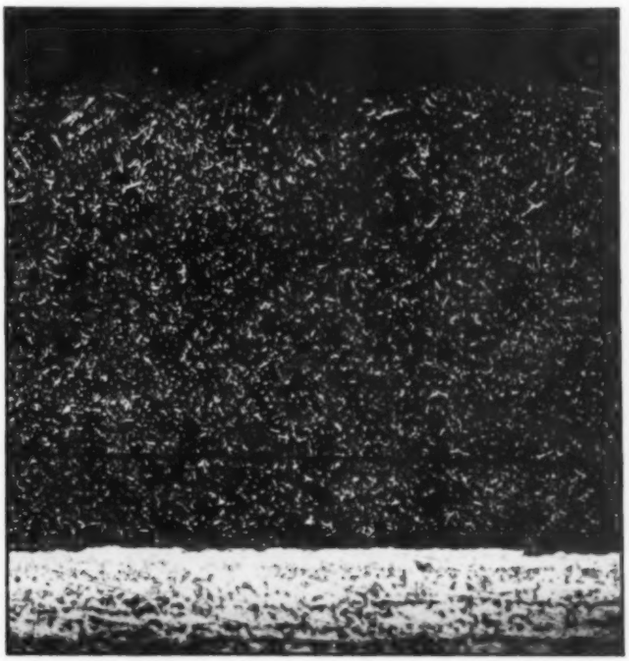
Figure 8 — This photograph (magnification 20X) shows the same lead base alloy given in Figure 7, but cast by the same technique into a very thick wall.

since due consideration must be given to the many controlling variables. However, an indication of the relative values can be obtained from carefully controlled laboratory test results shown in Figure 3.

These values demonstrate the remarkable improvements in fatigue strength obtainable in the newer constructions. Of course in actual applications, the nominal loading will be considerably less with attendant longer life.

In conjunction with this explanation of bearing constructions and characteristics, it may be well to state that hardness of the bearing metal is not a prime factor in realizing satisfactory service under high load, high speed, and shock encountered in applications such as rolling mills. Rather proper choice of bearing materials

Figure 9 — This photograph (magnification 20X) shows the normal tin base structure found in centrifugally cast material.



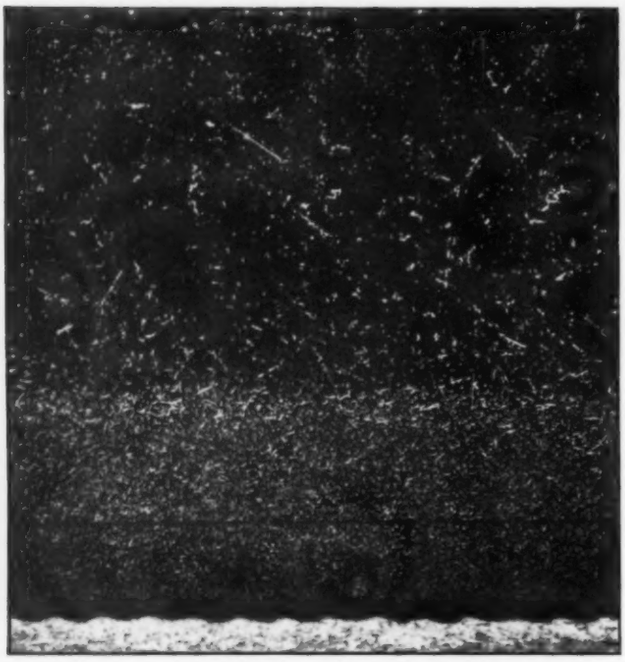


Figure 10 — This photograph (magnification 20X) which is for the same material as that of Figure 9, shows poor compound distribution and non-uniform particle size.

with their controlled thinness results in satisfactory fatigue as well as superior surface action under full fluid lubrication.

A discussion of bearing performance would not be complete without a few general statements relative to journal hardness, even though unusual conditions of high temperature, extremely high loads, insufficient lubrication, distortion, and misalinement may disprove these statements. Nevertheless, under acceptable operating conditions, the tin and lead base white metals may be used successfully is a wide journal hardness range of 170-1050 Brinell.

With the adoption of the copper-lead material, it has been the practice to heat treat the journal to a hardness of 500-550 Brinell. In considering the use of the trimetal bearing, which consists of the steel back, an intermediate layer of copper-lead, and a surface layer of trinary plate of lead-tin-copper, it has been possible to use a shaft hardness of 235-285 Brinell. However, it goes without saying that the harder the shaft, the greater will be the factor of safety for minimum wear, and the less the danger of seizure as a result of off-conditions of assembly or operation.

Insofar as journal finish is concerned, advantages may be obtained by machining the shaft with the same direction of rotation as is used in actual service, grinding against rotation toward the upper tolerance, and then lapping 0.0001-0.0002 in. with rotation so as to obtain a micro-inch finish of 20 maximum. The bearing surface should be a maximum of 30 micro-inches.

The importance of wall thickness on the final quality of the bearing, and its performance cannot be stressed too strongly as the tendency has been, and still is, to keep the wall thickness excessively heavy. This is definitely a "hold over" from the days of puddling babbitt into a cap, engine case, or rod, and then scraping the bearing in place.

In the past, the practice was to specify an extremely heavy steel or iron backing with both radial and longitudinal dovetails merely to obtain a mechanical lock for the bearing material (Figure 4).

The babbitt was weak in fatigue strength because of the non-uniform structure and the lack of chemical bond. More recently the elimination of dovetails and the practice of completely pre-coating the steel along with controlled cleanliness, temperature, and cooling rate has almost entirely eliminated defective bonding whether the method of casting be by the centrifugal, strip, or gravity process.

In an attempt to eliminate the practice of destroying a bearing in the "chisel check" for bond, many methods have been tried. "Black light" allows for a satisfactory check only at the edge of the bearing. X-ray will disclose spotty bond but will not differentiate between uniformly good and uniformly poor bond. Several methods of producing samples for tension tests have been developed which do not appear to be entirely reliable. Supersonic checks are satisfactory for major defects where discontinuity of poor bond is present. As a result, the "chisel check" remains as the most popular method of making this check.

Improvement in casting and quenching techniques also increased load carrying by increasing uniformity of the bearing material structure. However, it was quickly seen that an excessive amount of time and expense was required in preparing this heavy steel backing for casting and in quenching.

This experience made it necessary to conduct a study of casting and machining techniques on various wall thicknesses and diameters. The result of this investigation can be summed up as follows:

Figure 11 — Shown here is a micrograph (magnification 100X) of a high leaded copper alloy which has been gravity cast. The photograph shows the lining thickness as cast and the portion below the horizontal line is the "f" lining thickness.

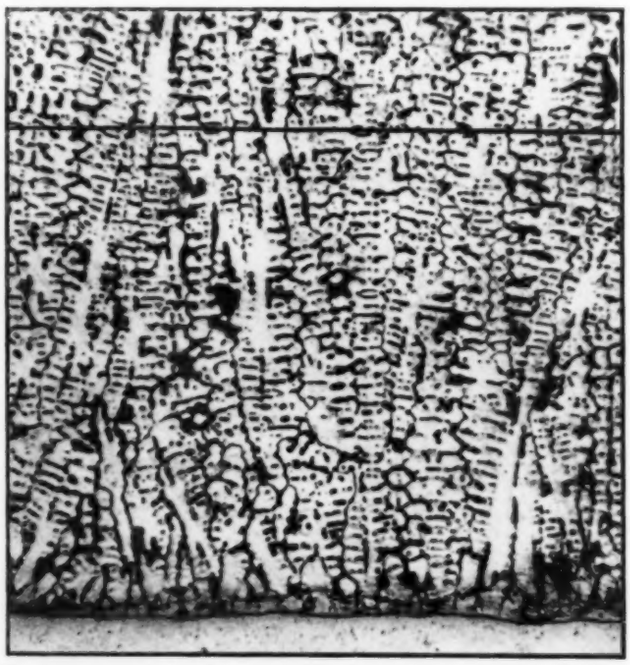


Figure 12 — This photograph which corresponds to that of Figure 11 (magnification 100X) was cast in a shell having a thicker steel wall. The lead areas began to coalesce into large areas, thus giving a much poorer type of structure.

1. Thinner steel backs allow for the casting of bearing material with increased uniformity and soundness, thus providing greater fatigue life or greater load carrying capacity.
2. Thinner steel backs result in appreciable reduction in cost.
3. Thinner steel backs allow for a more advantageous engine assembly and improved operation.

In discussing uniformity of liner material, maximum bearing performance is dependent on proper casting methods and quenching technique—whether the bearing material be of tin or lead base white metal, high leaded copper alloys, or cadmium nickel. As to proper method of casting—whether centrifugal or pour-in gravity method—the choice in the past has been fairly well limited by the alloy used. It is considered advisable to centrifugally cast the white metals, lead or tin base babbitts, or the cadmium alloys wherever possible.

Generally speaking, the leaded bronzes can be cast most successfully by the centrifugal method while the copper-lead alloys can be cast most practically by the gravity cast technique. However, recent developments indicate that some of the copper-lead alloys can be centrifugally cast successfully under carefully controlled conditions.

Quenching rate is, of necessity, closely related to the mass to be quenched, and is an extremely important factor in obtaining the ideal structure on all cast bearing materials. Because of this, it may be well to illustrate a few facts which prove the advantages obtained in using thinner wall bearings. See Figure 6.

Figure 7 shows a typical structure which results from a standard lead-base production centrifugal casting operation. A magnification greater than the 20X shown here reveals the white particles composing the antimony rich phase to be cuboid in shape. Their distribution from bond to surface is uniform, and their size nearly the same within a narrow range.

Figure 8 shows the same lead-base alloy cast by the same technique into a very thick shell. In this case, the white particles have all been concentrated near the "as cast" inside diameter due to the adverse casting conditions. It is evident that few of these crystals will be left in the finished bearing, consequently the actual bearing liner will be deficient in load carrying characteristics since the layer is more nearly pure lead.

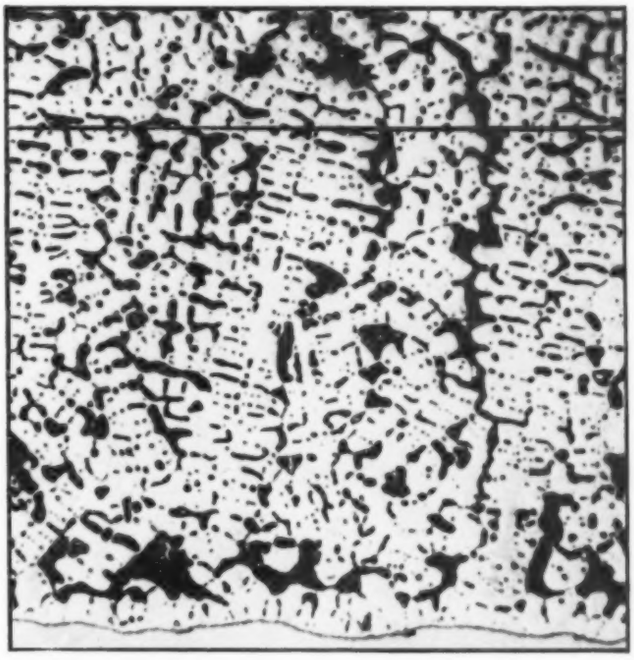
Figure 9 shows a normal tin base structure found in centrifugally cast material. The white particles in this instance are copper-tin compounds in a matrix of antimony-tin solid solution. The distribution is uniform and lacking in segregation.

Figure 10 shows a similar material having poor compound distribution and non-uniformity of particle size. The bond vicinity shows a wide band of compound concentration while the upper portion shows only a scattering of particles. This condition was caused by a longer cooling time because of the heavy wall. The difference in specific gravity between the solidified copper-tin compounds and the remaining liquid forces the compounds to be concentrated along the bond line. Since there is an excessive amount of this hard constituent present, the resultant structure provides an unsatisfactory bearing surface.

Figures 11, 12 and 13 are micrographs showing a high leaded copper alloy gravity cast into three shells with increasingly thicker steel walls.

Figure 11 illustrates how well the lead (which is the black areas) is broken up into small uniform islands and in each case is surrounded by dendrites of copper. Note how there is only slight evidence of lead concen-

Figure 13 — This micrograph shows the structure which was cast in a thicker shell than that of either Figures 11 or 12, resulting in a still poorer structure than that shown in the previous photographs. (Magnification 100X).



tration near the bond line which is at the bottom of the picture where only a narrow area of the steel is shown.

In contrast to this, note how the lead areas in Figure 12 have begun to coalesce into large areas, frequently connected together to form long fingers—the copper dendrites having nearly lost their identity because the lead has made deep, wide inroads between the branches.

Finally, in Figure 13 the lead has become a nearly continuous phase. Long, wide fingers of lead extend almost without a break from the bearing surface to the heavy line of lead which runs roughly parallel with the bond line itself. This extensive massing of lead opens wide avenues of corrosion which reflects in reduced bearing life. This increase in the size of the lead areas is almost entirely dependent on the rate of heat removal during the quenching cycle. It is well to stress again that the essential difference between the structures we have just seen is the increasingly slower cooling due to the increasingly thicker steel backs.

With this rather general background to a few of the phases which confront the bearing engineer in all his work it may be of advantage to consider a specific type of application. The history of rolling mill bearings shows a continual striving to improve bearing performance so that rolling mill practices may be more productive and efficient. This includes experiences with wood block bearings, babbitted housings, roller and ball bearings, and laminated resin bearings. There has been a renewed interest in the application of sleeve type bearings since true fluid lubrication has been incorporated.

Oil film or flood lubrication type bearings are designed to allow the full load of the rolling operation to be carried by the oil film, eliminating metal-to-metal contact. Failure of the oil film can be attributed to poor alinement, non-rigid bearing backing, plastic flow of the bearing metal, excessive clearance between journal and bearing inside diameter, water contamination of oil, dirt or scale in the lubricating system, and interruptions in the bearing surface caused by fatigue failure. See Figures 14, 15 and 16.

Figure 14 — This bearing failed because of oil film failure which allowed metal to metal contact and resultant seizure.

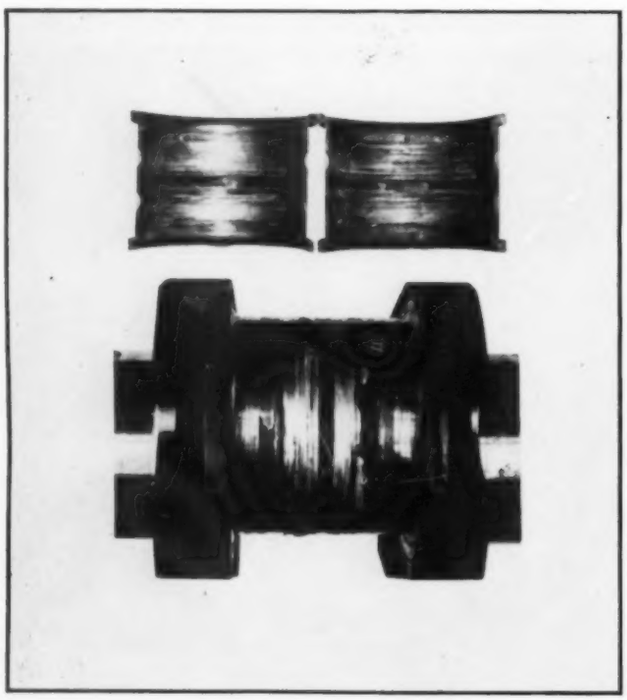


Figure 15 — This bearing failed because of excessive dirt in the engine assembly which resulted in high shaft wear.

A few of the critical factors in rolling mill applications will be very briefly discussed.

In the last two decades there has been a very definite trend to securely hold the bearing in the housing by a press fit. The use of thinner wall bearings permits the housing to master the bearing rather than the reverse. This type of design is being used today in the entire gas and diesel fields with the result that bearing troubles have almost entirely disappeared. There is considerable discussion in the heavy machine industry on such equipment as steam turbines, high speed reduction gear sets, and the type of equipment used in steel mills to change to this type of bearing assembly. The importance of this program cannot be overstressed because there are definite indications that a great deal of the bearing trouble in this industry has been due entirely to the fact that the bearing is not properly seated in the housing. In addition to this, it is necessary that the tolerances of the physical dimensions of these assemblies be within reasonable limits.

For sizes of bearings which are used in the rolling mill industry, it is rather difficult to give a measuring stick of the amount of taper and roundness which may be allowed on the bearing housing hole, the bearing, and the journal. However, we do have very definite information on the required tolerances in the gas and diesel engine fields. We will attempt to interpolate from the ex-

TABLE II

Standard Walls for Diesel Bearings

Shaft diam. in.	Wall in.	Lining thickness, in.
3 to 3⅞	5/32	1/32
4 to 5¾	7/32	1/32
6 to 7¾	9/32	1/32
8 to 9½	3/8	1/32
10 to 12	15/32	1/32
13 to 14	9/16	1/32
15 to 16	5/8	1/32

TABLE III

Standard Walls for Thinwall Bearings

Shaft diam. in.	Conn. rods in.	Main bearing and all others in.
1½ to 2⅛	0.0625	0.075
2½ to 3¼	0.075	0.095
3¼ to 4⅛	0.095	0.115
4½ to 5	0.115	0.125

tensive experience on the smaller bearings in order to give you an approximate indication of permissible tolerances on larger bearings. For example, in a bearing installation with a journal size of approximately 17 in., the following dimensions are suggested as permissible maximums:

Housing bore

Taper ..... 0.0010 in.
Roundness ..... 0.0020 in.

Bearing wall thickness

Taper ..... 0.0010 in.
Wall thickness variation ..... 0.0012 in.

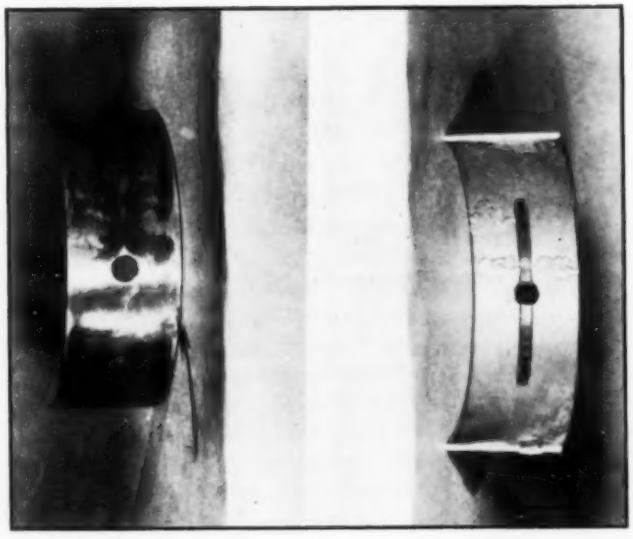
Journal

Taper ..... 0.0010 in.
Roundness ..... 0.0010 in.

The plastic flow of the soft babbitts is a common tendency where the bearing liner is greater than $\frac{1}{16}$ in. in thickness. Some of the current heavy bearing liner thicknesses cannot be prevented from flowing under many of the present-day loading conditions, giving rise to unsatisfactory performance.

Closely correalated with proper lining thickness, see Tables II and III, is the uniformity of structure within the bearing material itself. If the load carrying characteristics vary throughout the circumference and length, due to structure variations, additional difficulties can be expected. Centrifugal casting with a rigid control practice is essential for maximum uniformity that is so necessary for consistant bearing performance.

Figure 16 — A steel chip between the cap and bearing caused fatigue in a localized area.



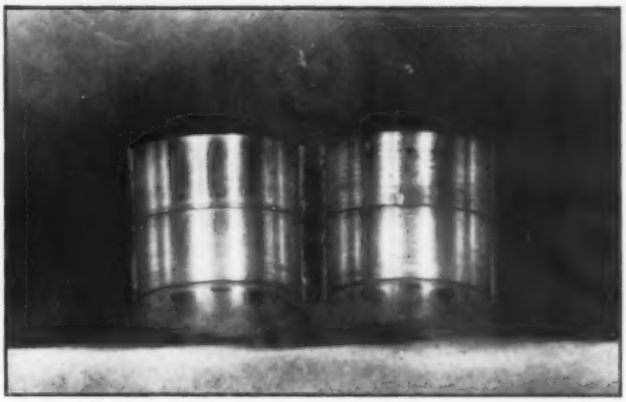


Figure 17 — A rough shaft surface caused a scored bearing and partial failure.

Too much emphasis cannot be placed on the importance of keeping the lubricating oil clean and up to its maximum film strength capacity. Water, grit, or dirt can destroy the results of all other care that may be taken. According to reports we have received, there has been some evidence of corrosion in rolling mill applications. These same reports further indicate that the oil in these corroded systems do not show products of corrosion by any of the general test procedures. However, corrosion in the internal combustion engine field shows that in every case of true corrosion the oil contained soluble metallic salts or soaps. Here it has been found that all bearing materials will corrode under adverse conditions, with tin base babbitt showing the highest resistance to corrosion. High operating temperatures generally result in a greater tendency for corrosion to occur. At low operating temperatures there has been no

Figure 18 — Severe overloading of the bearing material caused a severe fatigue failure.

reported evidence of corrosion of cadmium nickel bearings.

Corrosion discussions invariably lead to mention of oil additives. Our experience has indicated that neither the oxidation nor rust inhibitors have a deleterious effect on the common bearing alloys.

It is believed that many of the experiences and recent developments pertaining to bearings in the internal combustion field will in the near future be successfully adapted to the bearing practice in the heavy machinery industry.

DISCUSSION

PRESENTED BY

H. L. SMITH, Chief Metallurgist, Federated Metals Division, American Smelting and Refining Company, Pittsburgh, Pennsylvania

E. W. TREXLER, Superintendent, Mechanical Department, Bethlehem Steel Company, Johnstown, Pennsylvania

E. CRANKSHAW, Assistant Chief Engineer, The Cleveland Graphite Bronze Company, Cleveland, Ohio

J. H. HITCHCOCK, Director of Research, Morgan Construction Company, Worcester, Massachusetts

F. C. SCHOEN, Plant Engineer, The Midvale Company, Nicetown, Philadelphia, Pennsylvania

F. W. CRAMER, Electrical Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

F. P. DAHLSTROM, Consultant, Woodbridge, Connecticut

A. E. CICHELLI, Lubrication Engineer, Bethlehem Steel Company, Baltimore, Maryland

C. R. HAND, Assistant Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

NELSON F. THOMAS, Warren, Ohio

H. L. Smith: Of particular interest to iron and steel engineers are the difficulties which may arise when bearings are improperly made, and show segregation, and where such bearings must operate under improper alinement and distorted shafts. Too much emphasis cannot be put on the need for steel mills in general to improve their bearing practices to approach the progress and standards set forth in Mr. Crankshaw's paper.

E. W. Trexler: The paper was very constructive and interesting. The question that has been running through my mind is the application of a thin wall bearing to present rolling mills, maintaining the bearings in line, and the rollnecks in proper condition for a bearing of this type. Possibly in new mills, the bearing could be used, but I would anticipate considerable difficulty with scale, lubrication, and journal surfaces.

E. Crankshaw: It might be well to compare rolling mill bearing problems with those that have been encountered in the large diesel engine field in the last few years. With some shafts as large as 16 in. in diameter the misalinement problem has been a serious one.

The diesel engine presents alinement difficulties of even greater magnitude than roll neck bearings, since it is often necessary to assure the alinement of eight or even more bearings on one shaft. However, with consistent effort on the part of diesel engine manufacturers and the bearing producers, the present-day engines have little difficulty with misalinement.

One recent example within my realm of experience is the bearings on a rather small mill which at the time of our original investigation never ran more than two weeks without failure and the necessity of replacing them each time. At our recommendation, silver bearings with a one-thousandths inch of soft metal overlay were installed in this mill. Just the other day these bearings were removed for a general overhaul after a year and a half of continuous service. The bearings looked exactly like they did when they were first put into service. As to dirt, this is probably the greatest single cause of bearing difficulties in every application. Dirt must be eliminated if really satisfactory bearing performance is to be gained. I realize also that it is almost impossible to obtain dirt-free operation at times, but this is truly a problem you gentlemen must overcome yourselves.

J. H. Hitchcock: There is one question that I have in connection with the information. The figure shown for load-carrying capacity at 100 hours fatigue life indicates lower pressures than are common in most practical applications. The inference is that there was some peculiar arrangement of loading to produce accelerated fatigue failure. I would like to inquire if that inference is correct.

E. Crankshaw: Nearly all bearing fatigue study has been done on a modified Underwood bearing test machine. In the collection of these data, the only variable used was the increase of load to accelerate the fatigue failure.

An additional word as to actual roll-neck bearing loads might be expedient here. We have heard many stories of the great loads experienced in roll mill operation. However, again drawing from our limited experience it would appear that the mass of data based on internal combustion engine performance is certainly not directly applicable to your problem. As an example, we put a lead base bearing in a mill about a year and a half ago. The loads given to me at that time worried me greatly, for from our data under such loads that bearing should have failed at 50 hours or so. Yet, fatigue began to show only after better than a year's operation. So, the data as given can only be used as an indication of the way to proceed, and we hope you can use it as such.

F. C. Schoen: At the risk of being called "old-fashioned," I admit I have a fear of thin wall bearings around a steel plant. We know from our reading they are used in airplane and diesel engines, but in that type of application, as I understand it, the engines must be pulled down every 100 hours or so, and given a quick once-over, and every 500 hours, they are given a complete and thorough check, and practically rebuilt with everything that looks slightly worn replaced. This plan is not too practical in a steel plant. You can put another engine in an airplane, and keep on going, but you cannot

pull down a mill or a big piece of equipment for a complete rebuild.

Looking at the charts, Figure 1 showed a long bearing life, with a slight metal layer, one thousandth to five thousandths of an inch thick, with a marked decrease in life up to fourteen thousandths. Several years ago, we had occasion to rebuild four diesel locomotives, having light engines. It was a general overhaul, after a period of service of two or two and a half years. The engines came up fine with one exception. We had one journal on each of the six throw crankshafts that had to be built up, or trued up as it was scored. We did not have any success in building up, and we could not get any thin wall bearings to put in undersize journals, because at that time they did not want to bother making them for us. We ended up by buying new crankshafts for four engines. Perhaps, looking at the charts, they may explain it. The characteristics of the design would not allow us to put in a thicker lining, and maybe that was part of the reason we could not get a heavier bearing. In the particular case, if the bearing had been a little more liberally designed, with a smaller unit load, we might have been able to have built up the bearing wall, and kept the engines running without replacement of crankshafts.

Another thing I noticed in the paper, the life comparisons are all made under ideal conditions, cleanliness of oil being a big factor. It has been brought out this morning that cleanliness is something we would all like to have, but it does not seem to be too practical.

E. Crankshaw: When the diesel engine is brought into the discussion we feel perfectly at home, and will discuss it for any given length of time. Many things cause diesel bearing failures; such as, misalinement, distortion, or inadequate oil film which is a subject in itself, by the way. It might be well to add right here that the whole subject of lubrication, oil film strength, pump capacity, and running clearance has finally come under close scrutiny within the last few years. We have progressed far enough so that before a new engine leaves the drafting board we are able to tell the designer how much oil must go through the bearing to take away the frictional heat and give adequate lubrication. Because of this additional knowledge much of the guesswork has been eliminated.

We have hopes of being able to offer you people the same sort of engineering information some day after we have gained sufficient data and gleaned at least some of your "know-how."

Mr. Schoen has admitted that I have confused him a little. No doubt some of the rest of you find my point of bearing material characteristics a little hazy. So, if you will refer to Table I, "Relative Characteristics of Various Bearing Materials," possibly I can clear this up. In this tabulation we have incorporated all the common bearing materials, including the cadmium alloys which seem to have gained great popularity for roll-neck bearings. From this table the so-called white metal alloys are weakest in fatigue, the first column on the left hand side, they occupy the bottom of the column. While on the other hand these same alloys rate high in surface behavior. In contrast to these materials with their low fatigue strength, are the high leaded bronzes which are extremely high in fatigue, and with the proper overlay, also exhibit good surface properties.

F. W. Cramer: Would the author tell us how the proper clearances are determined. I refer to the space allotted for the oil to circulate and would like to know if this is a function of speed, load or just determined by experience.

E. Crankshaw: The clearance between the shaft and bearing surface under operating assembly conditions, like all other bearing factors, is very much dependent on the operation conditions. At the outset each factor such as probable distortion, possible misalinement, quality of machining, and available oil volume, which in turn depends on the amount of pump capacity obtainable, must be carefully weighed.

On some very large units such as ship propulsion, high speed gear sets, and steam turbines, a rough factor of 0.001 in. clearance per inch of diameter is used with babbitt bearings. Babbitt bearings in large diesels usually use 0.0005 in. per inch diameter, copper-lead alloys use 0.00075 in. per inch, and in other cases where silver or aluminum is used it is the practice to allow at least 0.001 in. or even 0.00125 in. per inch for clearance.

These same figures, it would seem to me, are directly applicable to the roll-neck bearing application.

As a word of general interest, in the automotive field where noise is a factor of considerable importance, the above figures are not used. For automobile engines which must run quietly a minimum vertical clearance of approximately 0.0002 in. is used. Taking into consideration the necessity for machining tolerances this clearance in any particular engine could vary from this 0.0002 in. total to a possible 0.0025 in.

Frank P. Dahlstrom: The charts showing the relation between bearing life and applied load are very interesting in view of the fact that flood lubricated precision roll-neck bearings carry greater unit loads with very much longer life than would be indicated from the paper.

During pioneer work developing a flood lubricated roll-neck bearing, the writer found by test that the performance of a relatively larger bearing was superior in certain respects to the performance reported for smaller bearings.

For example, much work was done with 2 x 2 in. bearings at the National Bureau of Standards. The results appear in the Transactions of the American Society for Mechanical Engineers previous to 1930. As a "yardstick" for comparing bearings the value $\frac{\text{Viscosity x R.P.M., or } ZN}{\text{unit bearing load}}$ was derived mathematically $\frac{ZN}{P}$ by M. D. Hersey and later proposed by him in 1914 and was subsequently used by S. A. McKee in his work at the Bureau. He found that when the value of $\frac{ZN}{P}$ was as low as five, partial failure of the oil film would occur.

The first roll-neck bearing unit built for test was about 8 x 8 in. and it was found that the critical value of $\frac{ZN}{P}$ was much lower, say, from ½ to 1. By this standard alone the roll-neck bearing could carry over five times the load than was indicated by Mr. McKee's test. He later found that with somewhat larger bearings and with heavier unit loads the critical value of $\frac{ZN}{P}$ was lower than it was in his earlier tests.

There are at least three factors which contribute to the superior performance of a roll-neck bearing.

1. Relatively higher order of precision. For example, if the finish of the 2 in. bearing surfaces was of the order of 100 micro-inches (which is 1/10 of 1/1000) the surface error relative to the bearing diameter would be one part in 20,000. For the pioneer roll-neck bearing we can assume the same value of accuracy—since the error is not dependent upon diameter alone—but on the grinding equipment. The error would then be of the order of 1 part in 80,000.
2. Compression of bearing and journal bearings under load. With a unit load of 3000 psi and with a total of 1 in. metal under radial compression, the combined yielding of the bearing and journal surfaces should be of the order of 100 micro-inches. For a 10 in. roll diameter bearing the combined yielding would be about 1/1000 of an inch, and so on up the line, until, for a 50 in. bearing, we might expect as much as 0.005 in. This yielding phenomena also sheds further light. If we compute the elastic curve of the center line of the roll neck under load by the standard formula we are at once faced with the fact that the deviation from a straight line is much greater than the minimum oil film thickness. From this limited theoretical viewpoint the bearing should not work successfully, as no allowance has been made for the compensating effect of radial deformation. McKee has shown that the maximum oil film pressure (at the center of the bearing) is 2½ times the average—therefore the maximum compression of metals at the center of a bearing, say 10 x 10 in., might be as much as 0.0025 for an average unit load of 3000 psi. This means that the deviation from a straight line might be as much as 0.0025 before we could expect oil film failure.
3. Reduction of "high" spots due to the combined effects of 1 and 2. As is well known, the strength of many bearing materials at the boiling point of water is about one-half that at room temperature. "High" spots cause local high temperatures, which in turn reduce the local clearances, which further increase local temperatures and lower the fatigue strength of the bearing material. It is extremely difficult to evaluate this effect in bearing tests and we must therefore recognize and allow for it when studying the paper by Mr. Crankshaw, which of necessity, can give us the applied unit bearing load only.

The early development work on roll-neck bearings indicated that an applied load of 3000 psi could be carried quite easily and that estimates of bearing life should be in years, rather than hours. Experience with these bearings has shown that still higher loads have been successfully carried in many installations.

E. Crankshaw: Mr. Dahlstrom's discussion has been most interesting, particularly since nearly everything we have found out is entirely in agreement with his statements.

Very definitely increase in shaft diameter reduces the critical nature of surface conditions from the load carrying capacity. I had considered mentioning this earlier, but since we are at the moment diligently searching for some satisfactory measuring stick, it seemed best to leave it unsaid until we can speak with some real accuracy.

There is one portion of Mr. Dahlstrom's comment that I would like to enlarge upon. That is, the $\frac{ZN}{P}$ formula has proven a valuable tool for our experimental work where the conditions are nearly ideal. Under practical operation, however, we have found it must be tempered somewhat.

In answer to the question as to test shaft size, the shaft used was approximately 2½ in. in diameter.

In the paper I mentioned 30 micro-inches as the maximum finish allowable. Please realize this is a very general statement. To express it differently, the allowable finish variation must be less than the oil film thickness. With that as a criteria, it is readily understood no overall figure can be given but specific applications call for different finishes to meet this requirement.

J. H. Hitchcock: I think a part of the confusion that appears here arises from the difference in operating conditions between Mr. Crankshaw's automotive practice, and the rolling mill practice which most of us are concerned with. In automotive practice, by the nature of the machine, the loads applied to connecting rod and crank shaft bearings are not uni-directional and sustained, but are intermittent; conditions that are ideal to promote fatigue failure. Furthermore, the parts employed in mounting crank shaft bearings, by reason of the merit of reducing weight, are made small enough so there is an elastic deflection when load is applied; again a condition which promotes fatigue failure. In rolling mill applications, by contrast, the load is in most instances uni-directional and sustained for a considerable period of time. It seems quite likely, and perhaps Mr. Crankshaw will verify this, that the differences in our experiences with respect to permissible operating loads arise from this difference in fundamental conditions.

E. Crankshaw: Mr. Hitchcock is absolutely right in his comment on uni-directional versus rotating load. Also, the occurrence of shock loading is appreciably less frequent in rolling mill practice than in automotive engine operation. This, no doubt, explains in part at least why even the small amount of data we have gained thus far pertaining to roll-neck bearing operation does not coincide too well with the mass of reciprocating engine information we have.

To clear up a point which I have apparently not made too clear, let me say that all during this paper when I spoke of thin-wall bearings I was visualizing a ⅝ in. wall for a 16 in. diameter shaft as a comparatively "thin wall." We have actually seen many roll-neck bearings which fall into this wall thickness.

Ignoring the actual bearing fabrication problems, the importance of having the machining on the housing, the bearing back, and the shaft so that duplication of assembly is possible is absolutely vital. The importance of not relying on some mechanic's individual idea but knowing the exact constant conditions in your bearing assembly cannot be too greatly stressed in uniform bearing life is to be expected.

A. E. Cichelli: I should also like to echo the fears of Mr. Schoen and say that we also are reluctant in using

bearings with thin wall liners, such as have been used in the diesel engine field. Nevertheless, we feel that perhaps in our steel mills we might be using liners that are too thick.

In our own plant at Sparrows Point, we believe there are several applications where thinner liners might present themselves as superior to the conventional thick liners. We have tried two applications so far. These were located in our service departments, however, not in our rolling mills. One is in our gas engine department on a 22 in. crank pin bearing for a gas engine generator. Normally, these liners are $\frac{3}{4}$ in. thick, and are made of tin babbitt. We reduced that liner to $\frac{3}{16}$ in. and are now operating with lead babbitt $\frac{3}{16}$ in. thick. Normally, that particular crank pin bearing has four longitudinal grooves, and four to six radial grooves. We reduced their number and their depth. We reduced them to two radially and two longitudinally, their depth, instead of the former $\frac{3}{4}$ in. was reduced to about $\frac{3}{32}$ in. This specific bearing was an experimental one made of bronze instead of steel. This was a concession to the possibility of failure, a steel shell would have ruined the pin. Babbitt was supplied by use of the torch flame method, which was discussed in one of our Philadelphia district meetings. We tinned it by wiping, and then applied the babbitt with a torch. After four months service, the bearing was removed and inspected. We have never had a finer looking crank pin bearing. The liner was as tight as when first installed. There was hardly any wear.

We had decided to develop this idea primarily during the war because of the possible tin shortage that eventually developed. Well, that has not eased very much. We were also looking for a testing place, where we could see what thin liners would do for us, with the possibility of reducing babbitt thicknesses in other locations in our plant.

I have one question I should like to ask Mr. Crankshaw. In his paper, I do not believe he discussed, or emphasized the importance of a chemical bond. I wonder if he would elaborate and tell us how he does obtain it, because it would seem that this is a critical factor in his thin wall bearings.

E. Crankshaw: As to this question of chemical bondings, I know of no way to over-emphasize the importance of truly good bond. The whole function of any bimetallic bearing depends so completely on sound bonding.

Basically all that is necessary to obtain chemical bond is clean steel, proper temperatures, and the solidification of the molten alloy unidirectionally. Depending upon both backing material and the bearing alloy, there is a whole series of preparation techniques. These techniques are indeed a multitude, ranging from solvent degreasing and alkaline cleaning through various acid pickles, to electrolytic molten salt cleaning. In addition to these are gas fluxes for both the babbitts and red metal alloy. As I mentioned above, the cooling, unidirectional cooling at a controlled rate is equally important.

As a final word, dovetails add nothing to the bond strength if the bond is correct, as it must be to function properly. Quite the opposite is true, dovetails frequently interfere with the obtaining of good bond since they tend to act as dirt, oxide or dross collection areas making chemical bonding virtually impossible.

C. R. Hand: As Mr. Cichelli has explained to you, we have been interested in thin-wall bearings, not only for the conservation of tin, but for the conservation of the dollars that we spend for it. We have many rolling mill bearings, where we put an inch, and some as high as an inch and three-quarters of babbitt into bearings, but to my mind the extension of thin-walled bearings is not just a matter of sending for Mr. Crankshaw, or somebody else in a similar line and saying, "Now, we want to put a thin-walled bearing in there." The fellows on the job have to be sold on this idea too.

There has been much development in rolling mill bearings. We have two different examples at Sparrows Point on our mills, where we have bearings with thin walls, and they are not entirely trouble free. There are a few factors that still require some attention, but I think that the majority of future mills will be built with liners, or thin-walled bearings, and they will be of the cartridge type. The problem of picking up an old mill built 20 years ago, and putting one of the newer design bearings in service involves quite a little study before this can be carried through, and it also requires, if you are going to get good results, an oil system that will guarantee to some extent, not necessarily 100 per cent, that the dirt contents in oil is kept at a minimum.

Nelson F. Thomas: The paper led me to believe that the success of this thin-walled tube depended also on a thin-walled back in order to get the proper quenching. It is my understanding, certain leading automobile manufacturers have stayed away from these thin-walled bearings in the crank shafts and caps, that is, the connecting rods and caps. Is it possible to get the effect of a thin-wall bearing and still maintain the heavy section?

E. Crankshaw: If I am not careful in answering your questions I could easily give away a few secrets which surround several new automotive engines. Sufficient to say, I believe, is that as soon as the new models appear, and they keep moving the date for their appearance ahead, there will be none with the bearing metal in the rods and caps. As of today, I know of no car where babbitt is cast into the case; but rather they all have interchangeable mains, as far as I know.

You can get satisfactory structure even with a heavy back, but from a practical operational standpoint it becomes very difficult. As an example, just to illustrate my point, consider our strip where we are casting 0.050 in. of babbitt on a moving strip of 0.050 in. steel which is traveling at 35 to 40 feet per minute. In this operation, the distance between the point where the molten babbitt is poured onto the strip and where it is completely solidified with a high pressure spray is about five inches. Saying it another way, the babbitt is completely set up in a little more than one-half second. Now visualize, if you will, a wall of an inch or so in thickness and calculate the amount of quenching media necessary to accomplish the same heat removal.

The same general procedure is necessary for obtaining satisfactory copper-lead structure with the exception that the strip travels somewhat slower and there is a greater amount of heat to remove so possibly the solidification time is twice as long. Again consider the volume of quenching media, no matter what it is, that would be required for a thick section if the same highly desirable structure is to be obtained.

Barium Lubricating Grease

.... barium lubricating greases offer interesting possibilities, particularly for high temperature and corrosion resistant applications ....

By C. J. BONER, Chief Research Chemist
and G. W. MILLER, President
Battenfeld Grease and Oil Corporation of New York
Kansas City, Missouri

▲ UNTIL the last few years the lubricating engineer who wished to use a lubricating grease was limited in his choice to one which was water resistant but low melting point or one which was high melting point but was not water resistant. Fortunately, there are now available barium base lubricating greases which combine water resistance and melting points up to 400 F. The experience with these lubricants in farm, automotive and industrial service has been very promising and this is particularly true of certain applications in steel mills. The purpose of this paper is to discuss the characteristics and applications of barium lubricating greases.

We hardly need mention that lubricating greases are soap thickened oils and that in order to prepare a satisfactory product both the oil and the soap must be considered. It goes without saying that a well refined oil should be used. Over twenty years of study has led us to the conclusion that the proper soap is as much a lubricant as the oil and with this in mind we prefer a soap which maintains a body at high temperatures rather than fuses to a liquid. Properly manufactured barium soap has this quality as will be demonstrated later on a hot plate.

Before we discuss what applications barium grease may have in steel plants and transportation equipment, it may be well to go over some of the reasons why one prefers to use lubricating greases rather than oils for jobs. First, grease is preferable where atmospheric conditions are dirty. Under such conditions grease will seal the ends of bearings, thereby preventing dust and dirt from entering. We might digress here and point out the necessity of prevention of contamination of lubricants after the containers are opened. A good lubricating grease mixed with dirt is not as good as a mediocre grease which is clean. All reputable manufacturers of lubricating greases are extremely particular to see that products leave their plants with no contaminants in them. For example, barium lubricating grease passes through Cuno filters with a maximum opening of 0.0008 of an inch before it is packaged. Second, lubricating grease is used when the location of bearings is such that they are inaccessible, since a grease lubricated bearing will require attention less frequently than one lubricated with oil. Third, lubricating grease is preferred where bearings operate under extremely severe conditions, such as high temperatures and extreme pressures. Fourth, bearings which must be lubricated in the presence of the washing action of water normally will render best service with lubricating grease.

It is interesting to note what happens to a lubricating grease in service. Grease structure consists of a soap matrix enmeshing oil. This matrix may be a mass of fibers, in some cases so small they cannot be distinguished even with magnification, or it may be a honeycomb structure. Irrespective of the form of this structure, it is what is responsible for the plasticity and resistance to flow of lubricating greases. When lubricating grease is subjected to shear and pressure as is the case when it is between two metal surfaces, the structure may change. The fibers may be broken and if this goes far enough, the product will soften and oil may be separated. The secret of a lubricating grease which will stand up in service is to have a structure which will not break down abnormally under the above conditions. This we have in barium lubricating grease. One of the reasons for this can be seen if you compare the soap content of lubricating greases of the same consistency, but made with different bases. We have taken a consistency of 265 to 295 in each case. Barium base grease has approximately 25 per cent soap, an aluminum base grease 10.3 per cent soap, a calcium base grease 11.5 per cent soap and a soda base grease from 8.5 to 14 per cent of soap. Thus, barium lubricating grease has almost twice as much soap as the other types. Another factor contributing to the stable structure of the subject grease is the heterogeneous nature of the fatty acids used in manufacturing the soap. We find it advantageous to have some very short chain length fatty acids together with some quite long chain

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 24, 1947

length fatty acids to form our soap. The barium molecule can attach itself to two fatty acid molecules and we surmise that in our structure we frequently have acids of different chain lengths attached to the same barium molecule. This provides a "complex" soap rather than simpler soaps which form the base of most lubricating greases.

This latter fact is also partly responsible for the more favorable reaction of barium lubricating grease to temperature than is true of lubricating greases of other bases. It is a general rule that pure substances have sharp or abrupt melting points while mixed products vary from this rule. In the case of barium lubricating grease we have the latter condition and on a small hot plate can be seen the difference in behavior to heat of barium and those made from other bases. The temperature of the hot plate is adjustable from 100 F and the heat is changed by 50 F increments, starting with 200 F. The hot plate is inclined slightly so that as the grease starts to break down or the soap to melt it is evident what happens. The first lubricating grease placed on the plate will be calcium base which melts and slides down as soon as it touches the hot metal. Next, aluminum base slides down almost as quickly. Now, two sodium base greases from different manufacturers: one fibrous, and the other of rather smooth texture. These do not move at 200 F but one of them starts to melt at 250 F and the other at 300 F. Following this a sample of lithium base grease is placed on the hot plate. This type is being marketed with claims for high temperature qualities. If we wait long enough this sample will move slightly on the plate at 300 F. However, if a sample of barium base grease is placed alongside it and after a short interval the temperature is raised to 350 F, the lithium grease starts to melt and runs off the plate, and the barium base grease still adheres to the plate. The temperature is raised to 400 F and the subject grease still stays in place which indicates that in service if you employed this lubricant it would remain in a bearing at or above this temperature when other types would run out.

You will see that these tests demonstrate not only the high melting point of this type of lubricating grease but also the quality of adhesion to metal, in which respect it also has superiority. This adhesion can be easily demonstrated if you will spread a little barium lubricating grease on a metal surface and then try to wipe the surface clean. In the laboratory we cannot clean it from a surface unless we use solvents and even then one application is not enough. This characteristic, together with the tendency to repel water, is no doubt responsible for the ability of this lubricant to protect metal surfaces against corrosion.

The high water resistance of barium lubricating greases is particularly important and has been confirmed by numerous service tests. In the laboratory it has been found that barium lubricating grease passes the Navy water absorption and leaching tests of Specification 14L5. This test consists of circulating a ¼-inch stream of water at 150 F over a quantity of lubricating grease held in a perforated cone and determining the loss after a 2-hour period. The qualities which make barium lubricating greases resistant to water are the fact that the soap does not hydrolyze and also that the soap does not emulsify with water. As produced it is

Figure 1 — A hot plate is shown that can be regulated by 50 F increments. This hot plate was first heated to 200 F, and a sample of calcium grease was placed on the top of the hot plate at the extreme right. Alongside of the sample of calcium grease was a sample of sodium high melting point grease. At 200 F the calcium grease melted and ran down the plate while, and at this temperature, the sodium grease still adhered to the hot metal. The temperature was then next increased by 50 F ranges to 300 F and the sodium grease now became fluid enough to flow down the face of the plate. At 300 F, samples of lithium and barium grease were placed on the hot metal and both greases adhered to the hot surface without running. The temperature was then increased to 350 F and at this temperature, the sample of lithium grease has become fluid and has lost its ability to cling to the hot metal. This step is shown in the photograph where the temperature is 375 F.

almost neutral and even on prolonged boiling with water there is no action on the soap. Sodium soap greases on the other hand do hydrolyze in water so that you may have both free base and free fatty acids. Some calcium soaps have this tendency also.

The qualities of barium lubricating grease which make it a versatile lubricant are both water and heat resistance, sufficient cohesion so that it does not drip, ability to maintain consistency on bearings, sufficient adhesion so that it resists centrifugal action, soft enough consistency so that it can be pumped with ordinary power-operated grease guns at temperatures as low as 35 F and by hand guns at a lower temperature, and lastly ability to prevent rust. These properties make this a lubricating grease which has wider application than others now available. Eastern steel mills have records of numerous applications of this lubricant, which indicate it is practically an all purpose lubricating grease. Mining companies, smelters, cement plants, gravel plants, rock crushing plants, packers, canners, breweries and construction companies standardized on this lubricant. As an indication of the versatile nature automotively of this grease, in automotive applications one lubricating grease can be used for chassis, wheel bearings, water pump, and universal joint lubrication. It also is an excellent covered spring lubricant. The advantages of an all-purpose lubricant are quite evident, for with one drum of grease instead of several, less space is occupied and greater cleanliness is possible. Further, there is little chance of using the wrong type of grease. Service stations have found an economy in using this lubricant in that about two-thirds as much is required as of all other greases to lubricate a given number of cars. To date, several million pounds of this lubricant

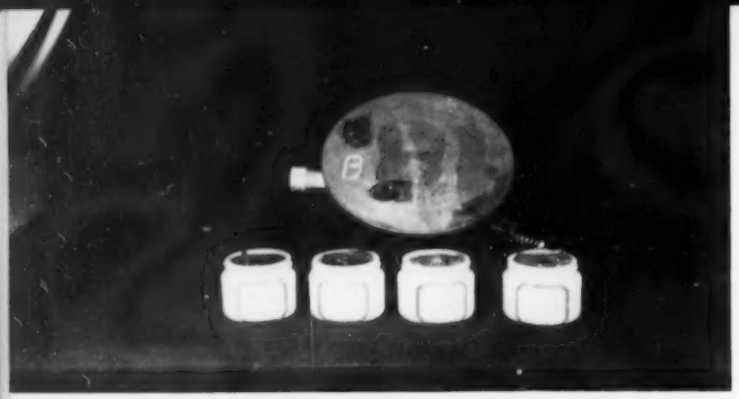


Figure 2 — At a temperature of 425 F, the barium sample still remains intact adhering to the hot surface. All other three samples have melted completely off.

have been used for automotive lubrication with outstanding success.

You will be interested in some specific applications in your own and other industries. An eastern steel mill by replacing several other greases with barium lubricating grease find less frequent greasing necessary, a lower grease consumption, and less error in greasing. Specifically: On their 44 in. bloomer screws, when rolling slab steel, it was necessary to shut the mills down several times a day to cool the screws. They now make a mixture of barium grease with a small amount of steam cylinder oil to increase the fluidity of the lubricant. Using this, they can now operate a full shift without shutdown due to the fact that the barium lubricating grease keeps the screws lubricated under extreme working conditions and high temperatures. On their 54 in. bloomer pit covers, where formerly it was necessary to lubricate the wheel bearings on the travel mechanism once or twice a day, since changing to barium it is only necessary to lubricate once a week with added ease of movement.

Barium is also used on ingot transfer buggy journals moving slab from soaking pits to bloomer entry tables. Formerly it was necessary to lubricate these journals several times a day and then difficulty was encountered in moving the cars, causing loss of time and damaged bearings. Since using barium it is only necessary to lubricate two or three times a week and there is no difficulty in moving cars. On the core and ingot mold oven cars in the foundry there was formerly much damage to cores and molds due to the fact that bearings would freeze and in an attempt to move the cars, the molds or cores would be broken. Average temperature in these ovens is about 500 F, the cars being at this temperature for about fourteen hours. The cars are now lubricated with barium before being placed in the ovens and in no case after such lubrication have any of the bearings frozen and all core and mold breakage due to rough handling of cars has been eliminated. On cold mill annealing furnace, fans operate under the furnace in conducted temperatures of approximately 1600 F. It was formerly necessary to lubricate fan bearings many times a day. Since changing to barium it is only necessary to lubricate the fan bearings once a day and in most cases, once every two days. Since the use of this latter lubricating grease was started there has been no loss of bearings. On up-draft fans over the boilers of this plant the bearing temperatures will run approximately 400 F on the high speed turbine driven fans (turbine end 5000 rpm, fan 750 rpm). It was formerly necessary to climb to the top of the boilers and lubricate daily. Since using barium the bearings are lubricated once a week and there has been no bearing loss during the past year.

In a western steel mill we have advice that the use of barium lubricating grease has simplified the problem of lubrication. It is also being used on several miles of conveying system, coke and skip cars, pusher machines, mud guns, door machines, shaker screens, etc.

Barium lubricating grease has been successfully used on flat steel and boiler plate in supply yards as well as on steel parts of towers, bridges, etc., for protection against moist air, salt water spray and even the direct impact of ocean waves. It has also successfully lubricated the governor control vanes regulating water flow to turbines where it displaced calcium base grease, which washed off with consequent corrosion. Dredging companies have also found that barium gave better service than other lubricants. The heavy trucks of a strip coal mine often have to travel through water and due to the loads carried and solvent action of the water, wheel bearing trouble was encountered until barium was employed. One of the most interesting applications of barium base grease was on the conveyor system used for moving aggregate at the Mt. Shasta Dam. On the main conveyor and plant lines there were approximately 85,000 bearings. Much of the equipment was exposed to atmospheric temperatures ranging from 10 to 130 F throughout the year, and the rainfall at times during the winter months was very heavy. In addition, dust and sand was always present in the vicinity of the bearings. In spite of such conditions this equipment operated most successfully for 3½ years.

In the plants of the packing or canning companies, the versatility of barium grease has been utilized. It is necessary in these plants to clean the equipment thoroughly at regular intervals during each operating day with water, steam and detergent. Many of the bearings operate in a wet or humid atmosphere at temperatures up to 200 F. Under these conditions, it is essential that the lubricant used in the bearings be both water- and heat-resistant and protect the bearing surfaces against corrosion, and that it should not be displaced from the bearing during the regular washing down operation with steam, water, and detergent. Furthermore, in some of the plants the severely corrosive action of certain fruit juices is a matter of major concern, and any grease that offers protection against corrosion is particularly valuable. Under all of the above conditions, barium grease has been used with highly gratifying results.

Of course mining companies have taken advantage of this versatile lubricant and one illustration of the use at a copper smelter will be of interest. The problem involved the lubrication of bearings on a conveyor moving blister copper from the furnace to the cooler. Because of the heat from the copper slabs, the steam and moisture attendant to the dousing of the slab for cooling, and the operation of a section of the conveyor under water at 200 F, satisfactory lubrication of the equipment presented a difficult problem. Thirty-two lubricating greases were tested and barium was the only one found satisfactory for the purpose. Lubrication costs were cut to one-quarter and the frequency of lubrication reduced from twice daily to once every four days.

DISCUSSION

PRESENTED BY

J. H. LEWIS, Lubricating Engineer, Carnegie-Illinois Steel Corporation, Clairton, Pennsylvania

G. W. MILLER, President, Battenfeld Grease and Oil Corporation of New York, Kansas City, Missouri

GEORGE H. DAVIS, Shell Oil Company, Pittsburgh, Pennsylvania

C. J. BONER, Chief Research Chemist, Battenfeld Grease and Oil Corporation of New York, Kansas City, Missouri

C. E. PRITCHARD, Chief Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio

W. H. MANDY, Lubrication Engineer, The Texas Company, Pittsburgh, Pennsylvania

N. I. WHITELEY, Lubrication Engineer, American Steel and Wire Company, Rockefeller Building, Cleveland, Ohio

J. H. Lewis: We have had quite a lot of experience on high temperature applications around our coke plant. The one question I would like to ask about the barium grease is: On the chuck screws on the oven doors—the operating temperature of the ovens is probably around 2050 F—the temperature in the area of the screw probably gets to a temperature of around 600 F. The present high temperature grease we are using we apply once every two weeks. Do you have any idea what would happen to your particular grease if we had oxidation and lost the oil? Would we get a solidified mass, or what would we get?

G. W. Miller: It is difficult to answer that definitely, but from past experience I would say you will not get the caking or hardening with barium grease that you would get with normal high temperature greases. While we do not always agree with the Norma Hoffman oxidation test as a test to indicate the oxidation or hardening of greases, we do know that the normal barium grease will run about six pounds pressure loss in a hundred hours, while most inhibited greases, that is, especially inhibited greases for oxidation will rarely go beyond five pounds, so the natural oxidation resistance is pretty close to a highly inhibited normal grease.

In car ovens where the temperature averages 500 F for a period of forty-eight hours and sometimes seven-day cycles, those cars are pulled without any trouble, and no hardening or caking of the grease in the bearing is evident. Now, that and the car mold oven operation would be the closest that I could recall at this time to your condition. You would get some hardening, of course, as you lose the oil. You would get a heavy grease remaining in your bearing surface but not a hard- tacky, pulverized product that you would get from normal greases.

J. H. Lewis: In conjunction with the use of these lubricants in our operations around the coke plants, are any extreme pressure additives being used in the grease?

G. W. Miller: No, there are not at the present time, although we are working on the extreme pressure phase of the addition of additives of that nature. There is no reason why they cannot be added successfully, but we have found that by the addition of any soap to a lubricating oil, you greatly increase the load-carrying capacity of the lubricant. Probably in ordinary oil it will take 8000 or 10,000 pounds, or 30,000 or 40,000 pounds with a soap base. With a double amount of barium soap you do get a much higher load-carrying capacity than you would with normal greases, but that, as I say, is in the stage of experiment, and we see no reason why high load-carrying capacities cannot be produced.

J. H. Lewis: In your experiences with the application of your product, what is the pumpability of it in extreme cold weather, say, around zero?

G. W. Miller: We have found this by actual tests made by several pump manufacturers: We take a one-hundred-pound container, for example, and with an electric pump, or an air pump, or even a hand pump, the grease will pump very readily at about plus twenty or twenty-five, and if a foil or plate is used in the container, even a piece of plywood or heavy cardboard is sufficient, it will pump at zero without any trouble.

George H. Davis: I am not quite convinced by the author's explanation of the explanation of the excellent high temperature stability characteristics of barium soap greases. It seems to me that the burden of his argument is that the barium molecule, being bivalent, can attach itself to two fatty acid molecules so that, when fatty acids of varying molecular weights are used, it is reasonable to expect that there will be frequent cases where the barium molecule is attached to acids of different chain lengths. Could not this same argument be applied equally as well to calcium soap greases because calcium is also bivalent?

We have found barium lubricating grease to be the nearest thing to an all purpose grease we know of, in fact, we like to classify it as the general purpose lubricant. It has been used on such diversified applications as run out tables and cooling beds of a 42-inch hot strip mill, babbitted roll-neck bearings of a slab mill, antifriction work roll bearings of a 4-high hot strip mill, annealing furnace fan bearings running at 3600 rpm, and many other applications where severe conditions are encountered. To bear out the "General Purpose" classification, we have several entire plants where all truly grease requirements are satisfactorily met with one product, "barium lubricating grease." I do not have to tell you that the savings effected through purchasing, inventory, removing the possibility of misapplication, and dispensing equipment are indeed very worthwhile.

G. W. Miller: We hide behind ignorance on this thing of structure, and while we will agree that calcium is a bivalent metal, we will not agree that all greases have the same fatty acids that we have in barium, and subsequently you will not have the same condition, that is, as I stated, we have some quite long chain acids.

The normal grease is made from a fat, which has primarily C-16 and C-18 acids. Now, we vary from that considerably in some cases, and, as I say, part of it is ignorance; it is just a surmise.

George H. Davis: Could you attain the same results by using the same acids with the calcium grease as you do with acids?

C. J. Boner: Not quite.

G. W. Miller: I might inject a word there. Perhaps part of that answer might be, due to the structure of the greases in all calcium greases, even in the fatty acid types, a trace of moisture must be necessary to develop a grease, and when that moisture is lost, you no longer have grease. The same thing affects sodium greases, although the reduced amount of moisture in sodium grease makes a better grease. If you get it beyond a certain point, you can change your structure. Barium grease does not depend on that factor. It is more or less of a true chemical mixture of soap and oil, which may be part of your answer as to bivalence and why one does and why one does not.

C. E. Pritchard: I might mention that in our field experience we have had some rather unique results in the use of the barium greases. However, I would also like to add the thought that I do not necessarily concur in every respect with the all purpose range of application for barium greases offered in this paper, based on our experience to date.

In one instance we have found a definite indication of what I would call a phase change taking place in the proximity of 300 to 350 F. The grease has actually been found to run out of the bearings completely in some instances where there was a decided drop in melting point noted during this phase change.

In other applications where we have continued the test up to approximately 400 F, we have noted a continual hardening reaction taking place, which, in turn, developed into a very severe lubrication problem. In other cases we have found that the product has developed into a very grainy structure which, to my way of thinking, would be a complete decomposition of the soap structure itself. The subsequent cooling of the product in this case did not show where the grease had returned to its original appearance as would be expected wherein the soap structure had been unaffected by the elevated temperature; this further substantiating the theory of complete decomposition.

I do feel that there is a definite place for barium greases in the steel industry. On the other hand I do not feel that it is as yet the strictly all-purpose grease that might be implied. Probably these conditions mentioned are due to the nonuniformity of the product as received. We definitely have had evidence of nonuniformity on several individual shipments to date.

G. W. Miller: I would like to answer Mr. Pritchard in this way There are distinctly and definitely two types of barium grease, and Mr. Pritchard's experience probably has been with the first, or basic, form. Am I right, Mr. Pritchard? Was the type of grease that you used a very smooth, buttery type of barium grease?

C. E. Pritchard: What I am referring to covers something that is very recent in addition to the products tested in the past couple of years. There were quite a few samples involved which were not confined to any one type.

G. W. Miller: Developments have been made over the past six months in the further perfection of barium grease that have eliminated some of the difficulties that you mentioned. We agree that originally there were some difficulties because of hardening at high temperatures and also in the apparent difficulty in the melting point at around 300 or 350 F. Like all products that are finally brought into us, as time goes on we find some of their failings and correct them and we know definitely now that some of the failings that you mentioned have been corrected in later developments.

W. H. Mandy: I would like to know if you have had any experience with the barium soap greases in pressure systems, where they are exposed to pressures of two or three thousand pounds for several hours or days continuous service. I have heard of a few cases where there was considerable separation of barium soap in the grease lines. Do you know what the nature of these greases are under these high pressures? Is there a tendency to strain out the oil from the soap?

G. W. Miller: I cannot answer that question. I, personally, have not run into that, or we have not done any work on that to date, unless Mr. Boner has.

W. H. Mandy: I think it is most important that we know this characteristic of a multi-purpose type grease because this grease is frequently used in grease systems which might become clogged if separation occurs.

G. W. Miller: We do know that the grease is being successfully used in one-shot lubricatoin systems through pipe lines and along pipe lines, and so far we have had no complaints on oil or soap separation even in pocketed areas where the temperature might be above normal, as running over a particular heat space where calcium greases or soda greases are used. Pressures there may run higher than 2000 pounds in those lines. Two mills in particular that are using it or have used it over some months have had no difficulty. That is the only experience we have had with it along that line.

Norwood Whiteley: I have not heard any questions raised about so-called fretting corrosions on roll necks with some of these greases. We have had experiences in this connection where roll necks are subjected to large amounts of water in hot rolling mills and also scale and high heat. With some greases, due to the vibration on the neck, a pitting effect is caused which is called "fretting corrosion."

I understand the Navy Department have some tests they have run on various greases which will tend to eliminate that type of corrosion, and I wonder if you have had any experience with barium greases under those particular conditions?

G. W. Miller: No. I am sorry to say we have not under those particular conditions. We do not know of a case where that particular condition existed when barium grease was used. However, as an anti-corrosion or corrosion protector, barium grease is a superior product. It definitely has high polarity, or the tendency to wet metal surfaces to a point where it will force water off the metal surface to prevent corrosion.

That can be demonstrated easily if you will grease your hands with barium grease and then try to wash it off. As you try to wash it off, it will cling closer to your hands than ever, and it is a very difficult job to wash it off your hands.

TWIN-MOTOR DRIVES FOR COLD MILLS

By R. H. WRIGHT
Westinghouse Electric Corporation
East Pittsburgh, Pennsylvania

. . . . twin-motor drives have the advantages of providing required power, torque, and speed properties in motors of standard construction . . . .

▲ THE present day cold mill is one of the paradoxes of modern engineering. This mill is designed for mass production of standardized materals. On the other hand, the development of the technique of cold rolling has been so rapid that as yet there is no standardized mill design. This applies particularly to the electrical equipment. The power requirements and the roll speeds have risen to the extent that it has been necessary to make a radical departure from previous mechanical and electrical designs.

A review of the horsepower requirements and roll speeds for the last stand of three recent mills will serve to illustrate the problems which arise when power and speed are increased beyond a certain point. Two of the mills in the following list were placed in operation in 1947. One is scheduled for operation in 1948. The speed and power requirements for the last stand of each mill are as follows:

Type of mill	Stand No.	Roll rpm	Drive hp
Sheet	4	219/548	3000
Sheet	4	250/580	4000
Tinplate	5	500/900	4500

To provide a conventional direct connected pinion drive for any of these conditions it is necessary to resort to special motor construction. For the first case, 3000 hp, at 219/548 rpm requires a double armature motor. Each armature can be of standard design. Three standard armatures are required for a motor rated at 4000 hp, 250/580 rpm for the second example. By using special design the number of armatures can be reduced to two. A triple armature motor of special design is required for 4500 hp, 500/900 rpm for the third mill. If standard construction were used, it would be necessary to have four armatures.

The drives for other stands of the same mills presented similar problems. In view of these conditions, it was imperative that some way be found to provide a more simple drive which would occupy the minimum space. Some arrangement by which each working roll was independently driven seemed to offer the best possibilities. After careful study, twin-motor drive was selected for the last two stands of all three of these mills. The speed and power requirements of the remaining stands were such that a single motor would provide a satisfactory drive.

Twin-motor drives were first used as a convenient means for applying exceptionally heavy power to large blooming and slabbing mills. The successful operation of the initial installations quickly demonstrated that the twin-motor drive had advantages which could be utilized in mills of other types. The principal operating advantages obtained for reversing hot mills are quite well known to be as follows:

1. The tendency for the rolls to chatter at the beginning of the pass is eliminated. This is due to the reduced backlash and the inherent freedom of the rolls to adjust themselves to the steel.
2. Higher entering speeds can be used and less care is required in entering steel in the rolls. Steel seldom fails to enter on the first trial.
3. Armature inertia is reduced. This leaves more

Figure 1 — Shown here is the first application of twin-motor drives for a cold reduction mill. This mill was a 56 in., 4-stand sheet mill and stands 3 and 4 had two 1500-hp motors each.

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 22, 1947

Figure 2 — The motors for stands 3 and 4 of Figure 1 are duplicates both electrically and mechanically.

torque for useful work or permits faster acceleration or both.

4. It is not necessary to match roll diameters exactly. With smooth rolls where pass area is not affected, differences in diameter of 5 to 10 per cent are not objectionable.
5. The amount of power which may be applied to a single pair of rolls can be increased without resorting to difficult mechanical and electrical designs.

An experimental twin-motor drive for a cold strip mill was tried out in 1932 in the shops of one of the mill builders. While this experiment was conducted on a comparatively small scale by present day standards, it demonstrated that independently driven work rolls could be used for flat rolled products. At about the same time a small four high cold mill with twin drive was installed in our research laboratories.

The first large scale application of twin-motor drive for thin flat rolled products was on a 160 in. four high reversing plate mill. In this application, the working rolls are each driven by a 5000 hp, 40/80 rpm motor. The excellent performance of this mill on all plate thicknesses down to $^3/_{16}$ in. has fully justified the decision to use twin-motor drive for its operation.

With this background of experience it seemed quite certain that a separate motor for each working roll would provide a satisfactory drive for a cold sheet or tinplate reduction mill. No major troubles had been encountered previously with pinion drives. However, with greater power and higher speeds the consequences of an error in matching work rolls could be serious. So the ability to operate safely with working rolls of unequal diameter at any load or speed made the twin-motor type of drive attractive. The small diameter of the work rolls and the necessity for keeping the angularity of the spindles to a minimum for high rotational speeds makes it necessary to use some form of gearing for each roll in order to provide space for the motors. Since the gear ratio does not have to be 1 to 1, the motors can run faster or slower than the work rolls. This arrangement has the compensating advantage that it will permit the use of single armature motors of conservative design. Chiefly because of these advantages, individual roll drive was selected for a part of the stands for each of the mills previously mentioned.

The first application of twin-motor drive for a cold reduction mill was for stands 3 and 4 of a 56 in. four-stand sheet mill. The mill drives, shown in Figure 1 are as follows:

Stand	Horsepower	Motor rpm	Roll rpm
1	2000	70/175	70/175
2	2500	130/260	130/260
3	2-1500	200/450	183/411
4	2-1500	200/500	219/548
Reel	600	150/600	150/600

All motors except the reel motor have single armatures. The reel motor has two armatures connected in series. The motors for stands 3 and 4, shown in Figure

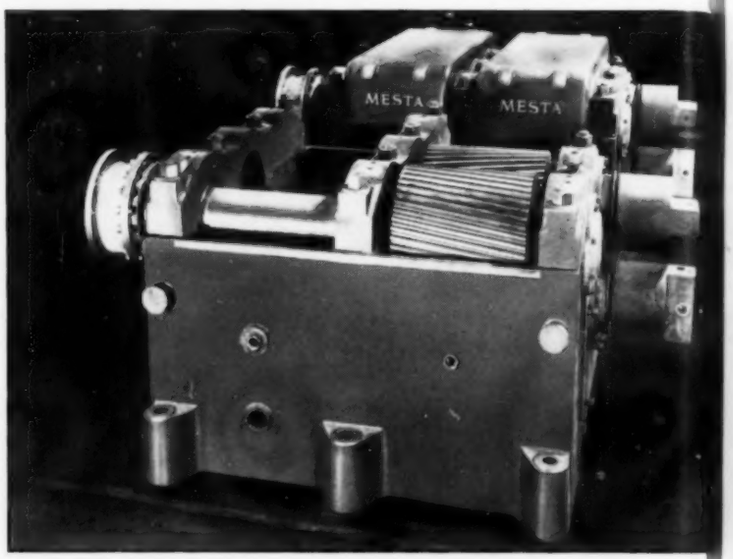


Figure 3 — The work rolls of stands 3 and 4 are driven through a speed reducer and a speed increaser, but the gear ratios are the same in both cases, thus enabling the use of duplicate equipment.

2, are mechanically and electrically duplicate. The motors for Stand 3 operate at 200/450 rpm. Each motor drives one 21 in. working roll through a speed reducer having a ratio of 42/46. The motors for Stand 4 operate at 200/500 rpm and each motor drives one roll through a speed increaser having a ratio of 46/42. This gives a roll speed of 219/548 rpm or 1205/3000 feet per minute. Figure 3 is a shop view of the gear units for these stands.

All motors operate on a common 750 volt bus which is supplied from an 8000 kw synchronous motor-generator. The only special feature of the control is the arrangement for dividing the load between the two motors of each twin drive. Each twin motor has an auxiliary field winding. The two windings are connected in differential series and are excited by a rotating regulator exciter. The fields of the exciter are connected in such a way that there is no voltage or current in the load division circuit when the motor loads are equal. Any tendency for unequal division of load causes current to flow in a direction which will strengthen the field of the motor with the greater load and weaken the field of the other motor. An IR drop booster is used for each stand.

The second installation of individually driven rolls was for a 42 in. five-stand tinplate mill. This mill is laid

out for a maximum delivery speed of 5000 feet per minute. The arrangement of the drives, shown in Figure 4, is as follows:

Stand	Horsepower	Motor rpm	Roll rpm
1	1750	70/210	70/210
2	3500	125/312	125/312
3	3500	225/450	225/450
4	2-1750	225/450	349/698
5	2-2250	250/450	500/900
Reel	800	300/1100	300/1100

The motors for Stands 1 and 2 are single armature machines. Number 3 motor has two armatures which are connected in parallel. Each work roll in Stand 4 is driven by a 1750 hp motor through a 76/49 increaser. The armatures are the same as those for No. 3 stand. Two 2250 hp motors, shown in Figure 5, drive No. 5 stand through 98/49 speed increasers. Figure 6 is a shop view of one of the gear units. The reel motor has two 400 hp armatures connected in series. All motors are connected to a common bus supplied by four 3500 kw, 750 volt generators. An IR drop booster is used for the drive for each mill stand.

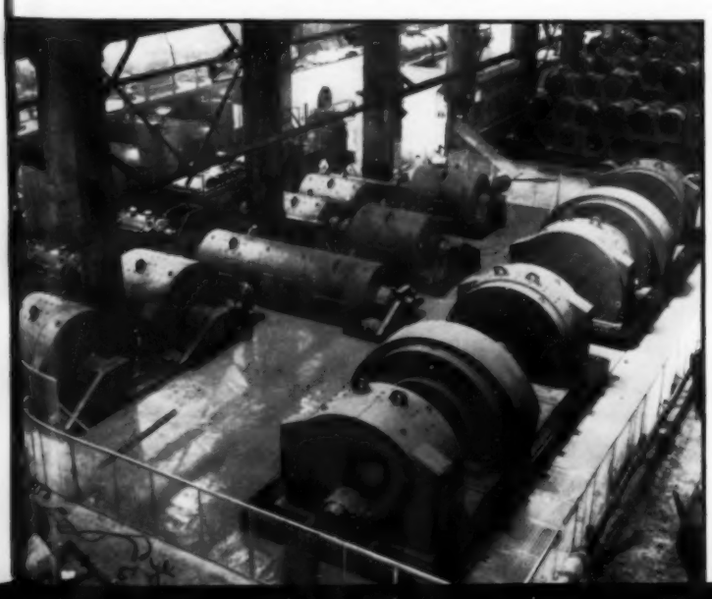
The design of this mill represented a marked advance beyond any previous experience available up to that time. On this account, the speed increasers for Stands 4 and 5 were each provided with a fifth pinion which could be installed if desired. This pinion ties all the spindles solidly together and make it possible to drive the mill stand with either motor or both motors in parallel as desired.

The drives for a 54 in. sheet mill now under construction will be arranged as follows:

Stand	Horsepower	Motor rpm	Roll rpm
1	2500	90/270	90/270
2	4000	125/360	125/360
3	2-2000	250/600	200/480
4	2-2000	250/580	250/580
Reel	800	150/600	150/600

No. 1 motor is a single armature machine, No. 2 motor has two armatures and No. 3 and No. 4 are twin drives, each 2000 hp motor having a single armature. A separate generator will be used for each stand. The reel motor has two armatures, connected in parallel and supplied from a single reel generator.

Figure 4 — The second installation of twin-motor drives which was a 42 in., 5-stand, tin plate mill had twin motor drives on the last two stands.



The 56 in. four-stand sheet mill went into operation in January, 1947. While this mill has unusual power and speed for a sheet mill and has a number of new features, including the twin-motor drives, it went into operation without unusual difficulty and has continued to operate in a normal manner. Normally, the rolls for the stands with twin-motor drives are matched and ground in the same way as for the other stands and for other mills. Operation with unmatched rolls has been tried out with entirely satisfactory results. The tonnage obtained with each grinding of the rolls is neither greater nor less than with the conventional pinion drive.

The 42 in. five-stand tinplate mill was started in May, 1947, and has since established excellent tonnage records. This mill has operated up to its maximum speed both with the working rolls of Stands 4 and 5 independently driven and with the motors mechanically coupled by the locking pinions. Roll slippage, strip marking and other random mechanical effects common to all cold reduction mills occur under the same conditions with either arrangement of these drives.

As is usually the case, anyone of several drive arrangements could have been used for these mills. The twin-motor arrangement was selected for the more difficult applications because it provided a compact arrangement of the drives and permitted the use of motors of conservative design. Considerable duplication of electrical equipment was made possible. The possibility of damage to the pinions of the highly powered finishing stands due to errors in matching work rolls has been eliminated. The operation is normal and entirely satisfactory. The use of twin-motor drive has provided a safe way to apply heavy power at high speeds with simple electrical equipment.

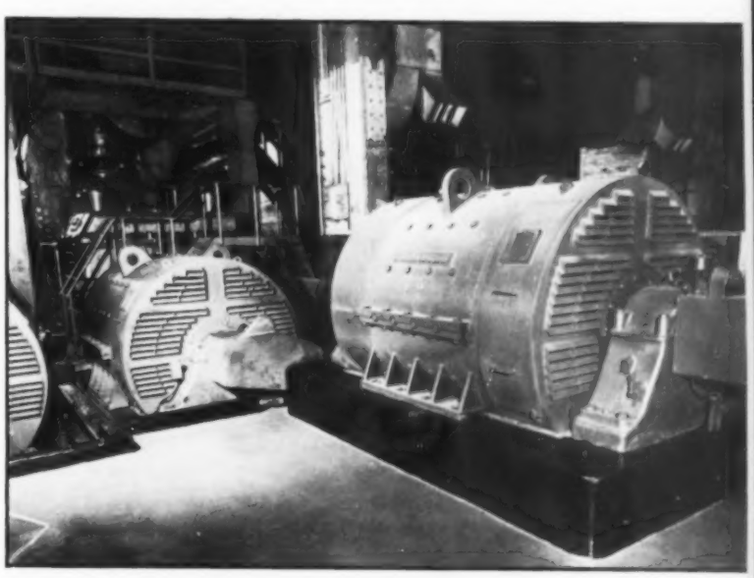


Figure 5 — The speed increaser on the fifth stand drives the roll at twice the speed of the motor.

The drive for a skin pass mill presents somewhat different problems. The rolls and strip in a cold reduction stand are lubricated as much as possible. A certain

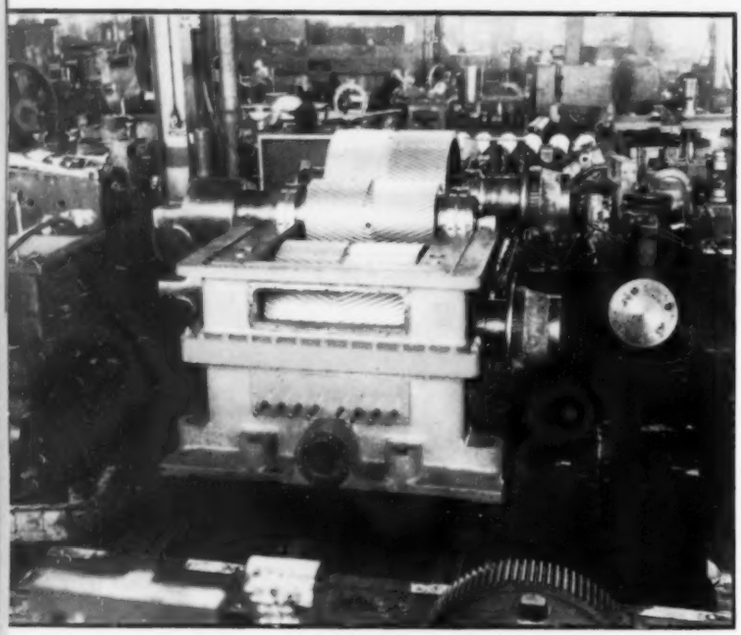


Figure 6 — This gear unit was used for the fifth stand for the 42 in., 5-stand tin plate mill.

amount of slippage can and does occur with no detrimental effects. On the other hand a skin pass mill runs dry so there is no lubricant to facilitate slippage of the rolls. To increase the difficulty, it is often desirable to grind the upper and lower work rolls to slightly different shapes.

Mechanical slip clutches have been used quite successfully with pinion drives to provide flexibility to meet these conditions. Sometimes only one work roll is driven. Probably the ideal drive is one in which each work roll is driven by a direct connected motor. However, this arrangement can be used only when the diameter of the rolls is sufficient to provide space for the motors.

Two 56 in. single-stand skin pass mills installed in conjunction with the four-stand sheet mill previously described have 21 in. diameter work rolls. It was decided that twin-motor drives of sufficient power could be provided for these mills. One of the drives is shown in Figure 7. Each roll is direct driven by a 400 hp, 60 C, 350 volt, 600 rpm, d-c motor.

The speed is regulated entirely by voltage control. This made it unnecessary to use poleface windings, thus reducing the length of the poles to a minimum. The field has six poles, whereas a motor of standard construction would have four poles for such a rating. This gave a considerable reduction in the thickness of the field frame. By such means a 400 hp, 600 rpm motor was obtained with an outside diameter of only 36 in. The motors are mounted on 20 in. centers. Ball bearings have been provided for all journals in the complete drive in order to obtain the maximum thrust capacity.

One of the mills has been designed for skin pass rolling of coils only and the other has been designed to handle either coils or single sheets. The roll drives have therefore operated under load conditions ranging from intermittent load to a few hundred feet per minute to steady load at 3300 feet per minute. The operators appreciate their complete freedom to use rolls of any shape which may be required to obtain the best product.

Due to its small physical size, the complete twin-motor drive is light in weight as compared with the mill parts. The inertia of the drive is only 3 per cent of the total inertia of all the rotating parts. The drive would contribute very little to the damage in case of a serious wreck in the mill and is not likely to suffer serious damage itself. On the other hand, because of this relatively small mass of the roll drives, it is necessary for the mill crews to exercise considerable care in changing rolls in order to avoid damage to the motors. They feel that they could save considerable time in making roll changes if they could be more free with the dolly. It is always wise to follow the suggestion of the mill man. Therefore, for any future installations of this type, it will be desirable to make the mechanical parts of the roll drive as heavy as possible.

Steel mill engineers long ago established a reputation for being continually on the search for ways to obtain economical production of increased tonnages of better steel. It is quite probable that the upper limits of speed, power and output of all types of cold mills have not yet been reached. The twin-motor arrangement has excellent possibilities for providing electric drives to keep pace with future demands for some time to come.

The further operation of existing installations and of other mills under construction will be watched with a great deal of interest.

Figure 7 — This twin-motor drive is applied on a 56 in., single stand skin pass mill.

DISCUSSION

PRESENTED BY

H. W. POOLE, Engineer, Steel Mill Division, Apparatus Department, General Electric Company, Schenectady, New York

ROLAND HESS, Electrical Engineer, Armco Steel Corporation, Middletown, Ohio

F. O. SCHNURE, Electrical Superintendent, Bethlehem Steel Company, Sparrows Point, Maryland

WALTER H. BURR, Superintendent, Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania

FRANK W. CRAMER, Electrical Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

E. T. LORIG, Chief, Senior Staff Engineering Bureau, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

R. H. WRIGHT, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

H. W. Poole: Mr. Wright has given us an excellent discussion of the reasoning in back of the use of twin drives for hot and cold mills in general, and cold reduction mills in particular, and has also given us some historical facts regarding the use of these drives. I am sure that he will not mind if I add a few more such facts to the overall picture.

Although the 160-in., 4-high reversing plate mill to which Mr. Wright refers was the first large scale twin-motor drive designed specifically for thin flat rolled products, because of unforseen circumstances a 44-in. 2-high slabbing mill driven by two 3500 hp, 30/75 rpm twin-drive motors actually rolled plate approximately $\frac{3}{8}$ to $\frac{1}{2}$ in. thick in September of 1943. Obviously, this two-high mill was not designed for plate rolling, but it so happened that the three-high plate mill which was associated with this slabbing mill was shut down for several days at an inopportune time, and since plate was so urgently needed for defense purposes, it was decided to roll it on the two-high slabbing mill. As a matter of fact, the first ingot rolled on this slabbing mill was finished down to a fine looking flat plate approximately $\frac{1}{2}$ in. thick to the surprise of everyone concerned.

Insofar as the application of twin-drive motors to cold reduction mills is concerned, you will be interested to know that as early as 1940, two 200 hp, 1750 rpm mill type motors were direct connected to the work rolls of a reversing cold strip mill, and that this mill has been operating successfully since that time as a production unit. Because of the small diameter of the work rolls and the attendant space limitations, these motors were mounted on opposite sides of the mill.

Six years later, in the early part of 1946, twin-drive motors were again applied to a cold reduction mill stand. This was also a reversing cold strip mill, but in this case each of the mill motors was direct connected to a back-up roll. This allowed locating the twin motors on the same side of the mill housing and did not require any gearing.

At the present time, one of the world's largest and highest speed tandem cold strip mills is being placed in operation. This mill is utilizing single armature twin-drive motors on Stands 3 and 4, and double armature twin-drive motors on Stand 5. In addition to utilizing twin-motor drives which are relatively new as pointed out by Mr. Wright, this mill will also utilize indivdual generators for each mill stand and this particular feature is of even more recent origin.

One other item which can be added to the growing list of twin-motor drives is a high speed two-stand temper mill which went into successful operation the early part of 1947. This mill has run at 3700 fpm and is equipped with twin-drive motors at 3700 fpm two mill stands, as well as on the delivery puller. The two motors on Stand 1 are each rated 400 hp, 575/750 rpm, single armature. The two motors on No. 2 mill stand are each rated 400 hp, 575/750 rpm, double armature. On Stand 1, each of the back-up rolls is driven by one of the twin motors, and on Stand 2 each of the work rolls is driven by one of the twin motors.

It is quite likely that the twin-motor drive will gain favor rapidly for many types of hot and cold mills, and that more and more consideration will be given to driving the back-up rolls as has been successfully done in several instances in the past.

Roland Hess: About the only thing we have at Armco in Middletown with twin motors is the slabbing mill, so we are not familiar with cold mill drives using twin motors.

I have a question I would like to ask concerning twin-motor drives. In dividing the load between the two motors for different roll diameters, this is probably done by measuring the current to each motor. I would like to know just how this is done to obtain equal torque on each roll. On motors that have double or triple armatures, are the armatures made all on one shaft, or are several armatures coupled together?

F. O. Schnure: The twin-motor drives on one of the sheet mills described in Mr. Wright's paper have been operating successfully for eight months. While the claims made for this type of drive are difficult to evaluate, there is no reason to believe they are not being realized. In this case, one of the advantages is in having the four motors driving the last two stands duplicates and another is in having them built in standard frames. The gear units are also duplicates as one is an increaser and the other a decreaser, both having the same ratios.

Load division as accomplished by the rotating regulator exciter has proven very satisfactory, the loading for all practical purposes, being identical. An illustration of its sensitivity was shown when trouble developed in one mill bearing causing the motor driving that roll to carry more load. The control immediately tried to speed the other motor up in order to take its share of the load. The operators noticed the difference in speed when the mill was idling. Investigation disclosed the unbalance to originate from the bad bearing.

The twin-motor drive will no doubt prove as successful on strip mill drives as it has on slabbing and plate mill drives.

Walter Burr: What provision, if any, is made when the back-up rolls are driven to prevent slipping between the back-up rolls and the working rolls on this type of drive?

Frank W. Cramer: The author of this paper has been active in the development of twin-motor drives for about twenty years. The 1930 proceedings of the AISE contain his first paper on this subject which describes the two twin-motor reversing drives that were installed on the 44-in. slabbing mill and the 54-in. blooming mill at the South Chicago works of what was then the Illinois Steel Company. During the intervening years, additional installations of twin drives have been made on large reversing mills and all are in successful operation today.

The majority of these mills have two 5000 hp motors with speed ranges up to 120 rpm. The usual operating range is about 0-80 rpm, and they are reversed with each pass.

The design for this type of drive calls for the shaft of the rear motor to pass over the frame of the front motor. Due to the physical size of the frame, the distance between the center lines of these two motor shafts has varied between 83 and 94 inches. The rolls on the mill are only 44 to 45 in. in diameter, and in some cases provision must be made for a 60-in. lift on the top roll. These conditions cause the spindles connecting the motors to the rolls to be inclined, and practice has limited this angle of inclination to about 5 degrees with the horizontal. This has resulted in spindles up to 36 ft 0 in. long. These inclined spindles have given satisfactory service and no reports of unbalance have been received. Another point we wish to mention is that it is possible to roll with one motor disconnected; the friction between the piece and the rolls being sufficient to turn the idle roll.

The above refers to low speed mills where the steel is not lubricated for rolling. Now the question is, does this same principle apply to a high speed lubricated mill?

The paper states that gear drives are used in order to get separation space to install the drive motors. The elimination of gears is one of the advantages of the twin-motor reversing drives. We know from experience that the long inclined spindles will work at 80 rpm. These direct connected tandem mill motors would run at about 800 rpm. Have any tests been run or calculations made indicating the upper limits of motor speeds where the 5 degree inclined spindle can be used?

The second point is the difference in rolling friction between a lubricated and a non-lubricated mill.

On the large reversing twin-drive mills, the top speed is only 120 rpm and in practice 4 seconds is about the usual accelerating time. On the high speed tandem mills we expect to accelerate up to 800 rpm in about 8 seconds. There is some doubt as to whether the electrical characteristics of the two motors and controls are so exact that this is possible. If it is not, then the friction between the rolls and the strip through the unevenly lubricated top and bottom surface must form the tie.

Actual experience on these mills will prove whether or not this is a reliable method for preventing slip of the rolls on the strip.

E. T. Lorig: Wherein lies the advantage of using twin roll drives on the final stands of five-stand cold reduction mills at maximum strip speeds of say 4500 fpm or less? Will such drives permit mismating of the two work rolls to a much greater extent than mills with pinion stands having a single drive for driving both rolls? Will the electrical speed control for the twin-motor drives permit such mismating, top roll large, bottom roll small and vice versa, without necessity for resetting of the control to secure the same peripheral speed of the two mismated rolls (different rotative speeds for both rolls and motor drives) particularly during rapid acceleration and deceleration, or does synchronization of the peripheral speed of the two work rolls depend in part, at least, on the frictional effect between the lubricated rolls and lubricated strip?

Under high operating strip speeds, say 4000 fpm, it is known that the lubricating effect between lubricated work rolls and lubricated strip is much more effective than at slow speeds, indicating that more lubricant per unit of strip area is being carried through the bite of the rolls and that the friction per square inch of strip area, between the strip and roll faces, particularly at the entering wedge, is considerably less. With mismated rolls, what reaction will this more effective lubrication have in maintaining synchronization of the peripheral speed of both rolls which are operating at different rotative speeds, including the rotative speeds of their respective twin drives?

Palm oil, in some tin plate production plants, is applied to the pickled surfaces of the strip at the continuous pickler. The application is not always very uniformly distributed over the full length of the strip and, at times, a great difference in lubricity exists between the top and bottom surfaces. Recoiling in itself does not uniformly distribute the lubricant on both surfaces. In cooling, after pickling and oiling, there are sections of strip within the coils that are heavily coated with a lubricant which, when cold, is grease-like and tenacious, whereas other sections may become relatively dry in storage or stock. While the above does not represent the lubricating practice prior to cold reduction as a general rule, yet it does happen occasionally and probably too often on individual raw pickled and oiled coils in varying degrees, and tenaciously lubricated sections usually persist in high lubricity in passing through the various mill stands and this lubricity is not evenly dispersed top and bottom over the full length being processed, regardless of the additional lubricant and cooling water supplied at the mill proper. Under such conditions, with mismated rolls and with somewhat different rotative speeds, top and bottom, as outlined above, what means are provided in the electrical control for the twin drive under high acceleration to hold the rapidly increasing peripheral speeds of the two somewhat different diameter work rolls exactly equal during this accelerating period? Is the electrical control so sensitive and accurate that high frictional effect between work rolls and passing strip need not be depended upon in part to secure synchronization of work roll peripheral speeds under high acceleration and high twin motor torque. It is not uncommon with conventional pinion equipped

stands in a five-stand tandem train for operators to encounter "squeeling" in a particular stand under conditons of lubrication as outlined in the paragraph above, associated most probably with light drafts required for some particular rolling schedule. With the pinion equipped stand such "squeeling" indicates slippage of the rolls on the strip, both top and bottom, which effect can usually be corrected by the operator without serious damage to the strip or roll surfaces. Under similar conditions involving slippage with the twin drive, what happens, particularly during the accelerating period? Is the electrical speed control sufficiently sensitive under such conditions to hold the peripheral speed of both work roll surfaces the same under unequal frictional effect between the strip and roll surfaces, top and bottom? If not, what will be the result? Is it not logical to assume that if a sudden variation in peripheral speed between the two work roll surfaces occurs, the slippage resulting will most probably occur in a pronounced manner on one side of the strip as compared with the other. If so, will not all fibers in the thin strip across its full width be subjected to markedly abnormal strains at the roll bite which will tear them all asunder as lubricity is reduced due to slippage under roll pressure and friction between roll and the strip surface again takes place?

Obviously, if slippage can occur on one surface of the strip as mentioned above, an increase in momentum will result in the slipping roll assembly and drive—top or bottom. Dissipation of the increased energy superinduced by any differential in momentum between the bottom and top roll assembly and drive in the twin arrangement can only be effected by two mediums: the strip itself, and in the case of strip failure, by frictional contact of both work rolls.

At the high rates of acceleration used today to bring tandem mills up from threading speed to say 4500 fpm, any slippage during this period could create quite a differential in momentum between the bottom and top roll twin-drive assemblies. Even slight differentials can be serious because of the mass and high rates of acceleration and operating speeds involved. Slippage of one of the work rolls on the strip, if it occurs, will start quickly but the inertia of the whole roll and drive assembly will prevent rapid increase in differential speeds between the top and bottom roll assemblies. The final increase in energy superinduced by the differential in momentum will, however, tend to be dissipated instantly as the sliding friction between the roll surface and strip changes to static friction under pressure. Instant dissipation of the increase in energy is, of course, impossible. Therefore, the strip will be instantly torn asunder or ground up in the roll bite as mentioned above, while the major portion of the energy will be dissipated in scoring of the two work rolls.

With twin drives, separate pairs of gears are required to drive each roll unless long universal coupling spindles are used, which application is somewhat doubtful for multiple stand cold reduction mills producing light gage cold reduced products under high screw pressure. Long spindles equipped with universal couplings, when inclined, do not in themselves rotate at constant speed per revolution and this, together with increased resilience, due to length when torque is applied in a twin drive, may well result in chatter or shadow marks on light gage strip.

Separate pairs of gears for driving each work roll, necessitates having the gear teeth at all times take whatever load is applied by the driving motors. Furthermore, the teeth must take increased pressures, due to increased motor loads and the energy of dissipating the momentum of the drive when a cobble or jam occurs. The question is, how long will such gear teeth last under the abuse of regular high speed operations? Will the teeth become peened down and worn rather quickly at the pitch line to the point where chatter or shadow marks will soon appear on the thin rolled strip surfaces? This remains to be determined, in our opinion.

With the conventional drive utilizing a pinion stand and a single motor drive (low WR^2 motors in tandem preferably) we have never known a pinion on a lubricated cold reduction mill to fail or wear excessively at the pitch line over a period of fifteen years. (This is not true of mills that are operated without lubricants for reducing purposes, such as dry temper mills). Why has there been no failures or undue tooth wear on such pinion stands? It is not because tooth pressures are, under normal operations, very light—never having to resist even half of the torque applied by the motor drive under such normal operating conditions?

When driving directly through one pinion to either the lower or upper work roll, the contact of the rolls on the strip under high screw pressure tends to rotate both the lower and upper roll assemblies, particularly under low rotative speed changes and at constant, fairly high speeds. Under such conditions, the pinion tooth pressures would, of course, theoretically approach zero with work rolls of identical diameters. Experiments made driving one work roll only on a lubricated mill indicated slippage, however, between roll and strip surfaces, making such an operation impractical for modern high speed mills. In actual practice, some differential exists between diameters of work rolls—probably 0.002 to 0.004 in. Additional differential in diameters can, in all probability, be tolerated when adequate and more uniform lubrication is developed and used. The differential diameters now used have no apparent deleterious effect on the surfaces of cold reduced tin plate, even though a slight differential in peripheral roll speeds exists. The creep, or slippage, of one roll or the other on the strip, due to unequal diameter of rolls connected by pinions, is so small per lineal foot of strip delivery, that the lubricating effect between the roll surfaces and the contacting strip surfaces is not destroyed under normal operations. In other words, the meshing pinions connected to the two work rolls with short spindles having little resilience or rotary deflection or twist under variable load, prevent abnormal slippage per unit of strip length under all operating conditions, including rapid rates of acceleration and deceleration when inertia and momentum energy values of the roll assemblies, pinions and drive come into play. This energy can do considerable damage to strip and mill alike if not controlled during acceleration and deceleration in a uniform and identical manner for both top and bottom work roll assemblies.

The pinion teeth are under normal operating conditions subjected to maximum tooth pressures during rapid rates of acceleration and deceleration. Such pres-

sures are not abnormal, however, as determined by operations of lubricated cold reduction mills over a period of many years. Jamming of the upper roll assembly with the lower pinion utilized as the driver would, of course, impose an abnormal pressure on the pinion teeth. This happens so infrequently on modern, cold mill equipment however, that jamming of either roll assembly separately is considered a minor factor in cold mill operations.

From the above discussion it would appear that little incentive exists to equip the final stands of five stand tin plate, cold reduction mills operating at say, 4500 fpm maximum strip speed with twin drives. Pinion stands have given trouble free operations on such mills at operating speeds of 3600-3700 fpm and little trouble should be experienced in providing for an increased operating speed of somewhat in excess of 4000 fpm utilizing pinion stands. The minimum WR^2 values of the rotating parts that can be obtained with tandem motor drives at such speeds should permit satisfactory operations with pinion stands when producing the lightest tin plate gages demanded. It is not advisable, therefore, to consider pinions rather than twin drives for five-stand tandem mills operating somewhat in excess of 4000 fpm when more adequate and effective strip lubrication is and should be provided and obtained to minimize the generation of heat while rolling.

Four-stand mills for the production of light gage wide sheets must eventually be operated in a manner similar to five stand mills utilized for the production of tin plate. Economical production of light gage wide sheets demands speeds of 2000 to 3000 fpm on such mills. The generation of heat while rolling must be minimized similar to that accomplished in the rolling of tin plate. For delivery speeds of 2000-3000 fpm on such mills, is it not advisable also to consider pinion stands rather than twin drives, utilizing a tandem arrangement of motor drive to minimize the WR^2 effect?

It is recognized that when delivery speeds of 5000 fpm or more are contemplated for five-stand tandem mills for the production of tin plate and say 3000 fpm or more for four-stand tandem mills for the production of wide, light gage sheet products that difficulties might be encountered in providing suitable tandem motor drives for such speeds, when utilizing pinion stands in place of twin drives—the difficulty being the operation of the increased number of motors in tandem for a low WR^2 drive when utilizing pinion stands. It should be recognized, however, that the higher the delivery speed, the better the lubrication between rolls and strip, necessarily so to minimize the generation of heat while rolling and to facilitate proper dissipation of heat to maintain contour control of work rolls in particular and the backing rolls. Minimization of the heat of rolling under extremely high speeds demands more adequate lubrication between work rolls and strip. Conversely, more adequate lubrication tends to increase the tendency for slippage between work rolls and strip and, therefore, demands more positive synchronization of the peripheral speed of the two work rolls. The question is, will twin drives permit positive synchronization at the periphery of the work rolls under high rates of acceleration, particularly at the extreme upper limit of speed-rise just before constant high speed rolling is effected, when the lubricating effect is greatest and the heat generation of rolling per unit of strip length passing is least? This, in our opinion, is questionable and may result in the necessity for gearing the twin drives together, if dual tandem motor drives are necessary, one for each work roll. With more effective and more adequate lubrication at delivery speeds of say 5000 fpm, or better for tandem five-stand mills, the heat generated per unit of strip length passing through will be less as mentioned above than now generated at speeds under 3600 fpm. The volume of heat generated per unit of time, however, will in all probability be greater for the higher speeds, and the question remaining is therefore: Can the volumetric increase in heat generated be dissipated sufficiently fast with known methods of cooling or coolants to prevent rapid absorption of detrimental heat by the work roll bodies—each unit surface area of which is subjected to the point of heat generation many more times per unit of time and conversely subjected to the cooling medium a much shorter period of time? In other words, can the work roll surfaces be maintained sufficiently cool under extremely high rolling speeds to prevent pyramiding of the heat in the body of the rolls so that roll contour and, consequently, strip shape can be maintained under strip speeds varying from threading speed to the maximum running speeds contemplated?

Somewhere there is a limit to the amount of heat generated under high running speeds which four or five-stands in a train are capable of dissipating when subjected to reductions such as being used today. Is it not logical to assume that if still higher speeds are contemplated, an increase in the number of stands in the train may be necessary to lower the reduction taken per stand and, in turn, lower the heat generated per stand, per unit of time—at the same time securing more cooling area in the mill train for more efficient heat dissipation?

H. W. Poole: I wish that I were at a little more liberty to discuss the one particular mill that I referred to where the back-up rolls are driven. However, we have been asked by the mill builder not to give it too much publicity or too much discussion since he has patent negotiations under way. I think, however, that by this time next year you should have a paper on that particular subject delivered before the Association. At least I hope you do.

However, it came to my mind that most of the Sendzimir mills, which are certainly well lubricated, as you know, are in this day and age driven through either the first or second set of back-up rolls. Although the first units of these mills were relatively small, there are some quite large ones, such as 40-in. mills at 1500 to 2000 feet per minute being built right now; and of course these mills are being built with a background which has already come from driving the back-up rolls on the Sendzimir mills that exist today.

R. H. Wright: I would like to thank Mr. Poole for his timely comments. At the time the paper was written, I knew that plate had been rolled in the Kaiser slabbing mill but was not sure of the date or circumstances. Mr. Poole's experience is somewhat like our own. Before they ordered the drive for the Homestead 160 in. plate mill, the Carnegie-Illinois Steel Corporation rolled a

plate in the 44 in. slabbing mill at the Edgar Thomson Works. There was some difficulty because a slabbing mill has no stripper plates and guides for handling plate. However, a plate was finished and that, and other considerations, convinced all concerned that a twin-motor drive would be satisfactory for a 160 in. plate mill.

It is also interesting to note that our first experimental twin-motor drive for a cold mill had motors on opposite sides of the mill. The drive would be simplified if such an arrangement could be used regularly but, of course, the mill operators would not like it.

Mr. Hess has asked about load division. The conditions are such that it is sufficient to equalize the armature currents by control of the motor fields, thus securing equal horsepower output from each motor. If the rolls are of unequal diameter, the roll with the larger diameter requires the greater torque and the lower speed and the motor with the smaller diameter requires the lesser torque and the higher speed. The horsepower requirements are the same. The armature currents of two motors supplied from the same source can be equalized by strengthening the field of one motor and weakening the field of the other. With proper connections, this makes the motors exert unequal torques proportional to the roll diameters at speeds inversely proportional to the roll diameters, with equal horsepower output. By obtaining equal division of armature currents in this way, all the conditions for correct operation are met.

In the design of large multiple armature motors for operation at high speeds, one of the problems is the elimination of vibration. To keep the shafts as rigid as possible, it is desirable to have a bearing support for each armature. So motors of this type usually are built with independent shafts connected by solid couplings and with a bearing between each pair of armatures.

I would like to thank Mr. Schnure for his excellent summary of his experience with twin-motor drives. His experience indicates that our chief aims have been attained—satisfactory operation with simple electrical equipment.

In answer to Mr. Burr's question, there is a limit to the contact pressure which can be obtained between rolls which in turn sets a theoretical limit to the amount of torque which can be transmitted by roll contact. As Mr. Poole has pointed out, a number of special types of mills have working rolls which are indirectly driven through backing rolls. So far, because of the possible limitations, the idea has not had wide acceptance for conventional four-high reduction mills. For temper pass mills which run dry and do not require much power, it is satisfactory to drive the backing rolls. Slippage in a backing roll twin-motor drive would be a serious matter as current balance control would do the wrong thing and the use of speed matching control would make the drive unduly complicated. It is for this reason that the use of twin-motor drives has been limited to applications for which it is reasonably certain that the driven rolls either slip simultaneously or not at all.

As Mr. Cramer has stated, the experience with long spindles, operating at appreciable angles, has been very satisfactory on slow speed twin drives for blooming, slabbing and plate mills. Also short spindles are operating quite well up to 750 rpm at moderate angles and low torque on skin pass mills.

For high capacity at speeds of 800 to 900 rpm, a small amount of wear quickly produces sufficient unbalance to interfere with the proper operation of the mill. For this reason, the mill builder likes to have heavily loaded spindles as short and as nearly horizontal as possible. Offset gearing has been used to obtain these conditions. No tests have been made to determine the maximum spindle angle which could be used. However, recent experience has shown that it is highly essential that all parts of a high speed cold mill be kept tight and free from vibration.

Mr. Lorig's pioneer work in the development of cold mills and years of careful analysis of cold mill operating problems provide a substantial background for his very proper and logical questions.

Operating experience on high speed cold mills has accumulated rapidly in the last few months as more new mills have gone into operation and their rolling speeds have been raised gradually to the design limits. Not all of the questions which quite naturally arise concerning twin drives for cold mills have been fully answered even at the time the discussion of this paper is being reviewed, which is several months after the original presentation. However, certain operating characteristics seem to be definitely established.

The basic assumption for every twin-motor drive which has been built to date is that the metal between the rolls will provide sufficient coupling effect to insure identical surface speeds of the working rolls. Operating experience with cold mills has shown that high acceleration rates can be used regularly without difficulty. Load division is maintained and there is no indication that there is any slippage which would not occur under the same conditions with pinion drives.

The usual practice is to match the working rolls just as is done with pinion drives. However, a tin-plate mill has operated successfully at 5250 fpm with the upper roll in the last stand 0.254 in. larger than the lower roll. A sheet mill has operated at a lower speed with a greater difference in roll diameter.

There is evidence that the amount and the distribution of the strip lubricant have some effect on the ease with which load balance can be maintained. It has been found that an ammeter which shows the internal operation of the load division equipment provides a good way to indicate how the oil should be distributed on the two sides of the strip. Also the amount of lubricant affects the tendency for both rolls to slip. It has been found that conditions which will cause slippage when the rolls are driven independently will also cause slippage when the motors are locked together mechanically.

So, for any conditions which have been encountered so far, the basic assumption seems to be justified. So far most of the high speed reduction mills which have gone into operation have had twin-motor drives for a part of the stands. As further experience is gained from these installations and from later high speed mills with pinion drives, interesting comparisons of operation and economics can be made. The equipment manufacturers will most surely want to be guided in the future by this experience.

Selecting Materials to Reduce Maintenance

By W. H. SPARR

International Nickel Company, Inc.

Pittsburgh, Pennsylvania

. . . . some of the steel industry's half billion dollar annual maintenance cost can be reduced by the proper initial selection of materials and design of equipment . . . .

▲ THE cost of repairs and maintenance to fourteen steel producers with blast furnace facilities, as reported to the Securities and Exchange Commission, amounted to nearly a half billion dollars in both 1943 and 1944. The actual total reported for 1944 was $484,322,000.00 which represents an average cost of 8 per cent of total net sales and these figures are probably no less today. Evidence of the potential reduction in these costs is indicated, not only in the fact that they are the highest reported by 76 major manufacturing industries, but also more significantly in the fact that they vary individually among the fourteen producers from 12.4 per cent of net sales down to 6.0 per cent. With this apparent potential translatable to profits, any and all means of effecting it should be of great interest.

Such figures for maintenance costs seldom, if ever include the cost of production lost through shutdowns for repairs or replacements. With the high rate of production of modern steel mill equipment, such lost production might reasonably be expected to far exceed either the high labor costs in making repairs or the material costs in preventing failures.

PREVENTION OF FAILURES

The potential reduction of maintenance costs through the prevention of failures is recognized in that the repair of parts and replacement of equipment draws considerable attention. Such attention is usually focused, however, on those parts where failure occurs either frequently with severe consequences and which, therefore, are considered to give inadequate service.

A great many applications exist where failures are either sufficiently infrequent or of so little consequence that they are regarded as giving adequate service and their repair or replacement is considered to be the normal incidence of operations. In one instance, coke crusher segments handled around 100,000 tons of coke before replacement was necessary. This was considered as adequate service life in this tough service and yet over 300,000 tons life was eventually attained when a change to an alloyed martensitic white cast iron was made. No part is above investigation as to means of improving service life; the potential reduction in maintenance costs is unknown without such investigation.

SPECIAL TREATMENTS

The application of special mechanical or metallurgical treatment may be effective toward preventing some failures on an economic basis. Sometimes heat treatment alone may raise strength or surface hardness sufficiently to reduce or overcome failure. This is particularly applicable to castings where, by breaking up the cast structure, the properties may be considerably enhanced. Cold working to raise fatigue strengths somewhat in local areas as in rolling the journal fillets on large press crankshafts, or flame hardening or induction hardening to improve wear resistance as in gear teeth or bearing areas on shafting also may serve in some instances to reduce failures.

Welding is commonly practiced in repairing breakage and such parts are returned to service with no design or material improvements toward prevention of a repetition of failure. There is even a likelihood of promoting failure through the weakening effect which can be introduced in welding. Some nail heading machine crankshafts are examples of this cycle. They are subject to periodic breakage and are repaired by welding, whereas design or material improvement might materially reduce the cost of their maintenance.

DESIGN

Design improvements alone can be effective in preventing or reducing failures, particularly those caused by stress, concurrent with material improvements they can be even more effective. Failures due to inadequate section size or to abrupt changes in section and to notch effects such as sharp fillets, oil holes, tool marks, shrink fits, etc., can be prevented by their elimination through design or through more careful supervision in the machining and installation of parts.

MATERIALS

Material improvements alone can also be effective in combating the destructive forces, particularly wear and corrosion. In preventing failures due to stresses, the use

If proper combinations of materials are not selected, serious corrosion troubles may occur as is shown here where the selection of a nut and bolt of dissimilar metals caused a serious corrosion condition.

of better materials is most effective in conjunction with proper design. While optimum service and full economic advantage may not be realized in the face of poor design, improved materials can nevertheless serve in themselves to reduce many such failures. It might be mentioned at this point that some failures could be avoided merely by insuring that complete material and heat treatment specifications be shown on the drawings.

A higher initial cost is expected of a material with special properties which enable it to render better performance in certain applications. Such materials contain either special elements or higher proportions of the usual elements and sometimes require special processing in production. It is not always so freely recognized, however, that they may be more economical to use. Thereafter, if an estimate can be made of labor and lost production costs due to failure, it should be a relatively simple matter to evaluate the economy of replacing a lower cost material with one of higher cost and superior properties for the service intended.

This might be demonstrated by an actual case which involved the replacement of engine bolts, where installation labor costs were between thirty and forty times the cost of the bolts and lost production costs and the cost of damage which resulted from failure of the bolts were many times greater. In this case, suitable alloy steel bolts would be required to last scarcely longer than the bolts which had been used for this costly item of maintenance to be reduced. For the service life obtained by using the alloy steel bolts, their initial cost was saved a countless number of times.

STRESSES

Stresses may lead to failure by breakage or distortion if they exceed the ability of the material to resist them. An improvement in this resistance may be obtained through an improvement in strength properties. In steels, this may be accomplished by suitable heat treatment, but often a change in grade is required. In the direct hardening steels, (normally over 0.25 per cent carbon) this change may be from carbon steel to one of the lower alloyed medium hardenability steels, or from the latter to one of the medium and higher alloyed deeper hardening steels. The nickel-chromium, chromium-molybdenum, nickel - chromium - molybdenum types comparable to the standard steels of the 3100, 4100, or 8600 and 8700 types are representative of the lower alloyed medium hardenability class. They are generally used in section sizes under 2 in, which is considered about the limit of their hardening power. Where stresses are of a low magnitude toward the center of a part as in torsion or bending, or where only high surface hardness may be required for wear resistance, these grades frequently may be used in larger sizes. The deeper hardening steels of the medium and higher alloy content, such as the nickel-chromium-molybdenum 4300 type in the standard steels, are generally used in section sizes larger than two inches. One of the chief advantages of these alloy steels, particularly the latter grades, is their ability to develop a high order of properties in larger sections and with less drastic quenching rates. These alloy steels are better suited to combat failures due to stresses, both static and dynamic, than are the carbon steels, as represented in Table I, which shows representative mechanical properties or resistance to stresses at approximately equivalent ductility. These properties may be somewhat lower when measured transversely to the

TABLE I

Heat Treated Properties

(At mid-radius quenched and tempered at 1000 F)

	Section size	Carbon steel (Water quenched)	8700 (Oil quenched)	4300 (Oil quenched)
Tensile strength, psi	2 in.	105,000	142,000	180,000
	6 in.	93,000	130,000	145,000
Yield point, psi	2 in.	70,000	118,000	165,000
	6 in.	55,000	105,000	125,000
Reduction of area, per cent	2 in.	50	55	49
	6 in.	48	56	45
Izod impact, ft lb	1 in.	38	31	34
Brinell hardness	2 in.	210	290	378
	6 in.	180	260	280

direction of rolling. Although higher hardness, tensile and yield strengths are obtainable in the steels shown in Table I at some sacrifice in ductility and impact values, and conversely the same relative comparison will hold true at other strength levels. While it is desirable from both the safety and operation standpoints to maintain a satisfactory degree of ductility in steel mill equipment in order that same warning may be had of impending failure, the advisability of sacrificing impact properties and ductility for improved tensile and yield strength (or conversely) will depend upon the specific application.

It cannot be over emphasized that to realize the optimum properties from the alloy steels, they must be used in the heat treated condition, preferably quenched and tempered.

It has been said that parts used in steel plant machinery are almost without exception subject to either repeated impact or reversals of stress or both. As these conditions may lead to fatigue or impact failures, a high order of fatigue and impact strength is desirable. Since the fatigue limit of steel with a polished surface is considered to be approximately half its tensile strength, (to about 200,000 psi) a high order of tensile strength, with adequate impact strength would seem to be important in fatigue service.

Because of the common presence of wear in the service of steel mill equipment, a high surface hardness is commonly sought concurrent with properties to resist other destructive forces. It can also be seen from Table I that a higher surface hardness is inherent with the alloy steels in proportion to their increased strength at equivalent ductility.

Shafting, gears, and pinions throughout the mill are excellent illustrations of the use of alloy steels in combating stresses to economic advantage. Other applications where alloy steels are being increasingly adopted to reduce maintenance costs will be found in such as crane axles, coupling boxes, spindles, steam engine crossheads and crankshafts, charging boxes and peels, trunions and hooks, welded chains, arbors, pig machine sprockets and chains and pins, manipulator cranks, levers, pins, crane track wheels, drawbench links, press and hammer rods, shear knives and liners, and a multitude of bolt applications.

For many applications involving metal to metal wear such as gears and pinions, reeler mechanism parts, pins, bearing races, etc., a low carbon steel (up to 0.25 per cent) is carburized to give a hard wear resistant surface. A high carbon case (usually around 0.90 per cent) of hardness up to 60 Rockwell C can be obtained. Such applications usually involve heavy pressures and high stresses where the use of alloy steels is almost requisite. The selection is governed primarily by the stress involved since the surface hardness is directly governed by carburizing conditions, temperature, time and subsequent heat treatment. For all but the heaviest pressures and the highest stresses, nickel-molybdenum steels of the standard 4600 type and nickel-chromium-molybdenum steels of the 8600 and 8700 types are generally applicable while for the heaviest service nickel-molybdenum steels of the 4800 type and nickel-chromium steels of the 3300 and Krupp types are generally required, particularly in parts of heavy cross section.

The use of stainless steel reduced the pitting on the leading tip of this turbine blade.

Other requirements such as heat treatment subsequent to carburizing, distortion, machining, etc., may have a bearing on the selection of the grade. The nickel-molybdenum steels of the 4600 type are generally the most popular, where the stresses in service are not too high, due to the lesser amount of distortion encountered in quenching them directly from the carburizing temperature.

WEAR

Wear always leads to eventual failure with consequent maintenance costs. It is said to be one of the most troublesome and persistent problems in steel mill maintenance. Abrasive wear as encountered with non-metallic materials of hard sharp particles such as coke, sand, sinter, etc., and metal to metal wear such as in gears, mill guides, table and coiler rolls, engine parts, etc., are responsible for a high consumption of metal in the steel industry. Several wear resistant materials, which can economically prolong the life of equipment and parts subjected to wear, are commercially available.

In metal to metal wear, where high stresses are involved, the use of alloy carburizing steels as previously discussed is often an economical approach. Nitriding with its shallower but higher case hardness may also be an economic solution to some wear problems as for example the nitriding of bearing areas on shafts. It may also be a solution to some wear problems at elevated temperatures up to about 900 F.

As has been mentioned previously, the heat treatment of some of the lower alloy direct hardening steels to higher surface hardness has been somewhat effective in combating metal to metal wear. It is often claimed, however, that wear resistance is more dependent upon carbon content than on high hardness alone. Illustration of this is to be found in the use of the high carbon chromium alloy steels such as the 52100 types used in bearing rollers, in pins, etc.

The presence of graphite in gray iron enables it to resist seizing and galling which enhances its usefulness in frictional contact with other metals. Its wear resistance may be increased by raising the hardness through

suitable alloy additions such as nickel, chromium and molybdenum. Because of these properties, it is quite widely applied in cylinders and liners, bushings and bearings, table and coiler rolls, sheaves, etc. The familiar austenitic manganese steel containing around 1.0 to 1.4 per cent carbon and 10 to 14 per cent manganese, better known as Hadfield manganese steel, is very commonly applied in applications involving wear. Sometimes 3 to 5 per cent nickel is added and carbon reduced to prevent embrittlement in very heavy sections or where the material is to be welded or is to serve at elevated temperatures. Austenitic manganese steel depends entirely upon work hardening through high impact or heavy pressure in service to develop the high hardness (approximately 550 Brinell) responsible for its wear resistance. In the presence of such work hardening, as in crusher jaws and mantles, bucket teeth and lips, trackwork, hammers, etc., it is an extremely tough and wear resistant material. Perhaps due to familiarity with its abrasion resistance in these applications, it is frequently mis-applied, however, in frictional or sliding abrasion in the absence of the necessary battering action and in these cases it is little better in wear resistance than mild steel.

In such applications the abrasion resistant martensitic alloy white cast irons with hardness ranging from 600 to 700 Brinell show a remarkable superiority in straight abrasion resistance over other materials. Wearing plates and chutes of this material in coke service have given an actual service life in specific cases of thirty times that of steel plates. In coke conveyor trippers, this material has outworn several other materials from 7 to 25 times. It has a wide field of application in the sintering, blast furnace, and slag plants, in wear plates, Muller tires, pug mill paddles, coke crusher segments and rolls, grizzly discs, clinker teeth, chutes and wall plates and in ash and slag conveyor pipes and pumps. Blast furnace wear plates and certain upper bell hopper plates have been replaced with this material to economic advantage. It is also used in some mill guides where abrasion is the prevailing factor, particularly in bar mill guides. Its application in composite metal for coiler rolls and even table rolls has been considered because of the service life expected on the basis of its abrasion resistance.

Like austenitic manganese steel and unalloyed chilled white iron, it is not machinable and must be cast and be ground to size. While it is sensitive to thermal shock and is not amenable to welding, it has served at sustained elevated temperatures without breakage, as in the case of wear rings inside rotary kilns. It is, however, lacking in impact strength in terms of steel.

For those abrasion applications where high stresses or sudden loads are likely to cause breakage of cast iron and yet sufficient battering is not developed to work harden austenitic manganese steel, there are several types of steel which will resist abrasion and stress. One of the more commonly used types is the medium manganese steel containing about 1.5 to 2.00 per cent manganese with carbon in the range of 0.50 per cent. An illustration of its superiority to austenitic manganese steel in the absence of battering action is in coal tipple and conveyor chutes where this medium manganese steel handled about 2.4 million tons of coal in comparison with only 1.5 million tons for the austenitic manganese steel. In the same application, mild steel handled 1.1 million tons.

In large section sizes or where it may be desirable to maintain hardness and abrasion resistance to greater depth on normalizing, the high carbon (0.50 to 0.60 per cent) varieties of some of the nickel-chromium and nickel-chromium-molybdenum steels such as the 8600 and 4300 types may be applied. There are many special and proprietary and alloy abrasion resistant steels with high carbon content, particularly in castings, which may serve the same purpose.

Abrasion is often associated with corrosion in handling wet materials such as wet coal, slag, etc., and abrasion resistant properties may not be so important in selecting a material as a combination of abrasion and corrosion resistance. In such cases it is difficult to evaluate the relative effect of each of these factors and a service test may be required. In this type of service, some of the low nickel-chromium-molybdenum types of steel, previously discussed, as well as some of the low alloy high tensile proprietary steels, have shown an improvement in service life over carbon steel and the medium manganese types of abrasion resistant steels. An example of this is to be found in the use of proprietary low alloy high tensile steel in some coke quenching cars where corrosion is associated with abrasion. The high nickel austenitic cast irons exhibit good abrasion and corrosion resistance in certain environments and have been found to improve the service life in both abrasive and metal to metal wear in the presence of corrosive conditions. Examples of this can be cited in pump casing and impellers handling blast furnace waters carrying finely divided slag particles and also in liners of piston pumps handling sand and corrosive oil.

The sharp fillet turned into this six inch shaft caused a fatigue failure.

CORROSION

Corrosion extracts a high toll in metal in the steel mill, particularly in hot gas corrosion or oxidation, as

evident by the heavy scale on equipment subjected to high temperatures.

The effect of corrosion may be reduced by means of suitable coatings ranging from plating or sprayed metal to paints or even tar or plastic coatings, although constant attention may be incurred by this approach, thus defeating the objective of minimizing maintenance costs. The study of corrosion, and particularly wet corrosion is a highly specialized field and the problem of combating corrosion generally should be left to the corrosion specialist if one is available. There is, however, sufficient information generally available with regard to the corrosion resistance or corrosion rates of various materials to enable a test to be made of the most likely materials.

In pickling equipment, the application of corrosion resistant materials such as monel, stainless steel, silicon bronze, and a few of the non-ferrous alloys is quite well established and their relative performance is quite generally known. In the by-product coke plant, corrosion may present unique problems and should be left to a corrosion specialist if possible. In galvanizing and tinning, the application of ingot iron or its nearest equivalent practicable, should exhibit the best resistance to the corrosion of molten zinc or tin and this at best is none too good.

Atmospheric corrosion and corrosion from wet materials can be combated effectively by the proprietary low alloy high tensile steels, the medium alloy types previously discussed, the stainless steels or the non-ferrous alloys, depending on specific conditions of service.

A considerable amount of carbon steel is used, much of it internally water cooled, in contact with gas temperatures upwards of 1200 F. In these applications, a substantial saving in maintenance and replacement costs appears possible through a more extensive use of the austenitic stainless steels and heat resisting alloys of the 18 per cent chromium—8 per cent nickel, 25 per cent chromium—12 per cent nickel, 25 per cent chromium—20 per cent nickel, and 35 per cent nickel—15 per cent chromium types. Considering that the initial cost of these alloys may vary from ten to twenty times the initial cost of carbon steel, a service life from them of something less than this ratio would prove profitable, taking into account the labor and lost production costs as discussed previously. The comparison in Table II of the scaling rates of carbon steel and 18-8 which costs roughly ten times the cost of carbon steel, up to the maximum temperature at which 18-8 is applicable demonstrates adequately the economies possible.

TABLE II

Oxidation Rates

(Grams/sq in. lost in 1000 hours heating in air)

	1250 F	1500 F
18-8	0.01	0.03
Carbon	1.95	5.61

For temperatures above 1500 F, the heat resistant types similar to 25-12, 25-20, 35-15 and 60-15 will prove of even greater economy of use than 18-8 based on the comparison of their oxidation rates in Table III.

TABLE III

Air Corrosion Rate

(Inches per year penetration)

	1600 F	1800 F	2000 F
18-8	0.015	0.13	0.60
25-12	0.0055	0.037	0.085
36-16	0.004	0.013	0.064
60-12	....	....	0.039

It should be realized that these data are based on laboratory tests and are not necessarily reproducible in plant operation, although they do serve to give an indication of the relative performance which might be expected. Comparable data are available for service in oxidizing and reducing flue gas.

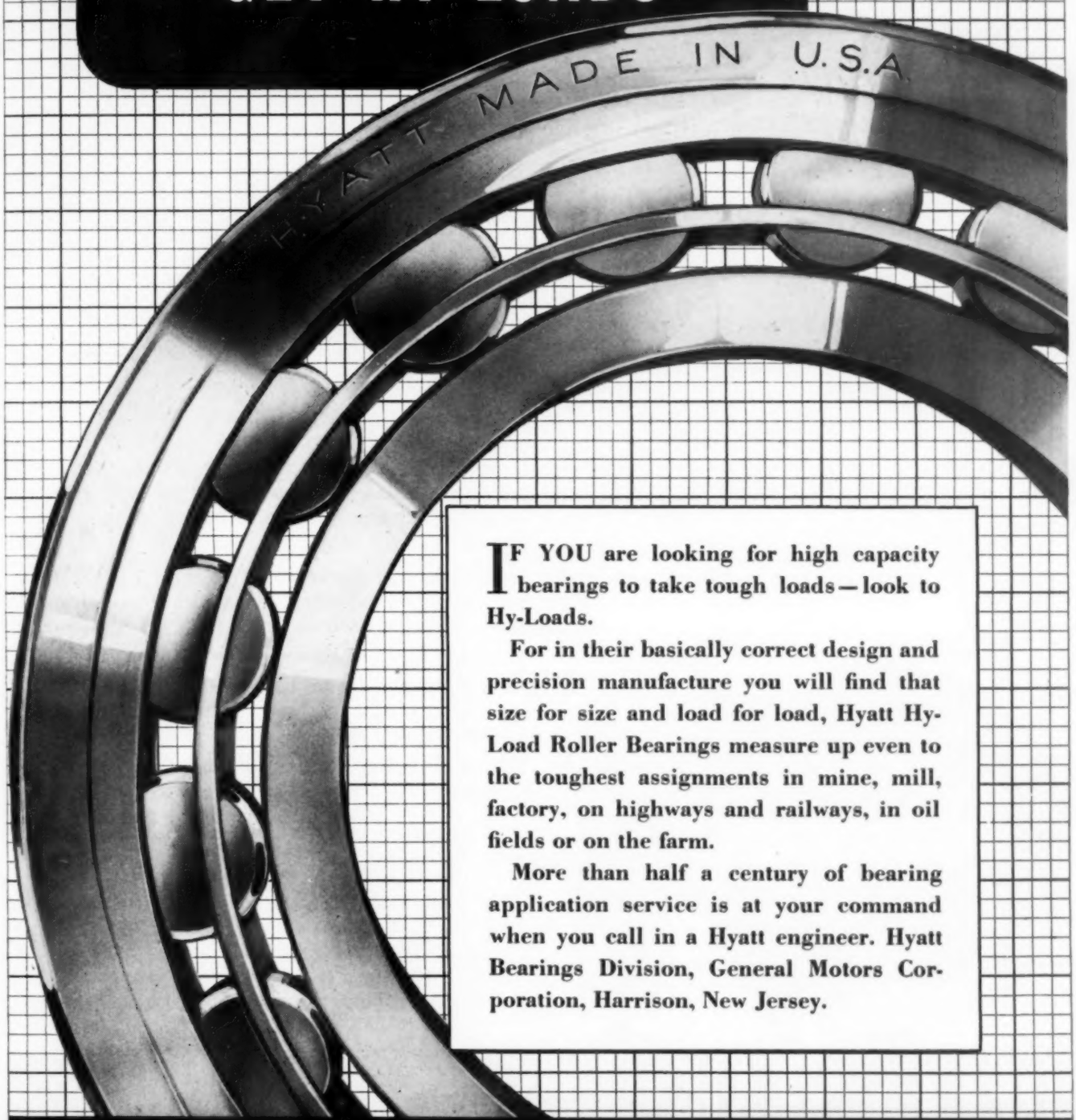
It must be emphasized that the use of the high nickel types such as the 35-15 and 60-15 must be avoided in the presence of appreciable quantities of sulphur. The presence of 25 per cent chromium is claimed to be sufficient to protect the lesser amount of nickel from the sulphidation which might otherwise occur.

In addition to their superior oxidation resistance, these heat resisting alloys maintain a high order of elevated temperature strength (creep and stress rupture) with extraordinary impact resistance and ductility. Because of this unusual combination of properties, they are best suited for the many applications involving high stress and impact at temperatures which would cause a high or prohibitive oxidation rate in the structural steels. The large potential in reducing costs in high temperature applications through the use of these heat resistant alloys is increasingly recognized with the continuing widespread application of them. Outstanding among these are blooming mill guides, annealing boxes and coil annealing covers, sheet furnace skid bars, car type annealing furnaces, damper doors, soaking pit cover frames, open hearth door frames, soot blower nozzles, billet furnace skids, heat treating furnace boxes and trays, burner nozzles, muffles and even as cladding on the exterior or gas fired wire galvanizing pots.

In applying these heat resistant alloys, cognizance must be taken of their lower thermal conductivity and their higher expansion characteristics and adjustments made in design to avoid high thermal gradients and differential expansion which could lead to distortion and cracking. The fact that they may be and generally are used in lighter sections than possible for the carbon steel in the same application is an additional factor in their economy.

None of the factors discussed herein, design changes, special treatments, and more suitable materials, can in themselves accomplish the optimum in reducing all types of failures. The most effective approach to an overall reduction in high maintenance costs is believed to be through the utilization of an effective combination of these factors. It is hoped that this discussion may stimulate thought and action with what can be done through the application of better materials.

FOR TOUGH LOADS GET HY-LOADS



IF YOU are looking for high capacity bearings to take tough loads—look to Hy-Loads.

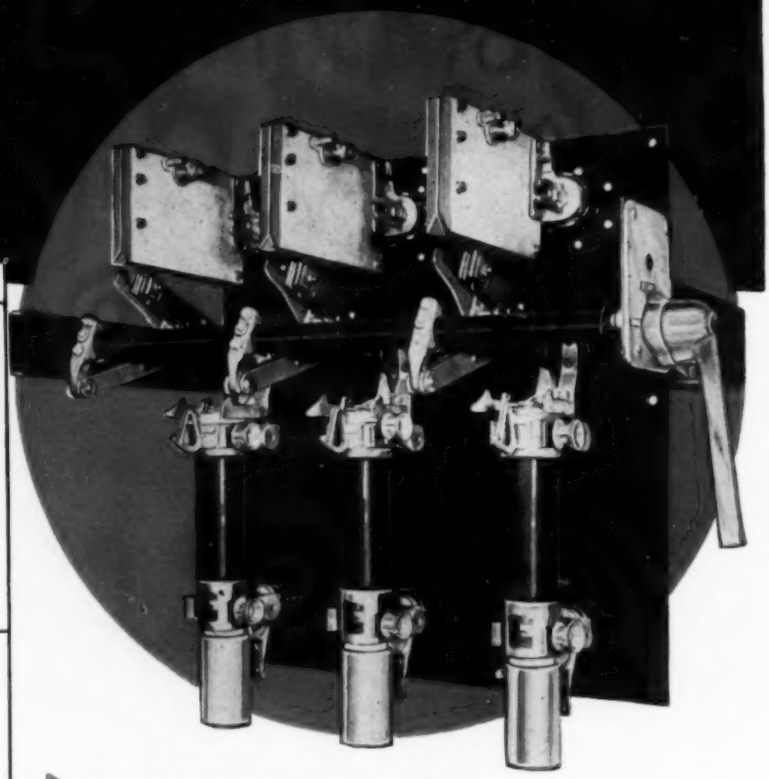
For in their basically correct design and precision manufacture you will find that size for size and load for load, Hyatt Hy-Load Roller Bearings measure up even to the toughest assignments in mine, mill, factory, on highways and railways, in oil fields or on the farm.

More than half a century of bearing application service is at your command when you call in a Hyatt engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

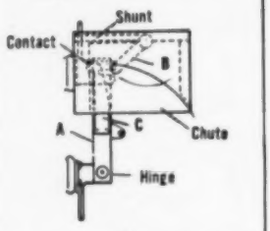
NEW DUAL PURPOSE DISCONNECTING SWITCH

The Delta-Star type "SL" interrupter switch combines the functions of isolating switch and load interrupter—permitting opening of load current up to 400 amperes with absolute safety.

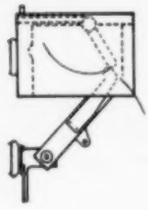


SEQUENCE OF OPERATION

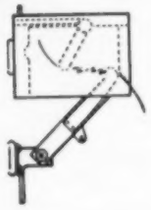
1. Switch blade closed. Current path thru contact, switch blade (A) and hinge.



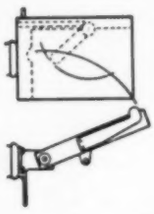
2. Switch partly open. Current path thru auxiliary blade (C) and retracting blade (B).



3. Switch partly open. Auxiliary blade (C) and retracting blade (B) are parting. Spring returns retracting blade to neutral position, arc is drawn inside chute.



4. Switch fully open. Arc is quenched. Circuit interrupted.



A - Main Blade

B - Spring Actuated Retracting Blade

C - Manually Operated Auxiliary Blade

- Ideal for isolating transformers, capacitors and voltage regulators. In combination with power fuses it provides a low cost means of fault protection.
- Load interruption is accomplished by rapidly elongating an arc established within a confining chute when main contact opens, as shown in figures 1, 2, 3 and 4.
- Ample tests under all rated values have proved the ability of the "SL" switch to meet these conditions with a liberal safety factor.
- The type "SL" switch is a NEMA Class A interrupter and is furnished in the following ratings:

NEMA Voltage Rating	Continuous Current Rating (Amp.)	60 Cycle Interrupter Rating
5000	400–1200	400
7500	400–1200	200
15000	400–1200	100

See Display in Booths 216 and 217

FOR COMPLETE DESCRIPTION AND LISTING ASK FOR PUBLICATION 4612.

DELTA-STAR ELECTRIC COMPANY

MAIN OFFICE AND FACTORY — 2400 Block, Fulton St., Chicago 12, Ill.

NEW YORK OFFICE — 140 Cedar St., New York 6, N. Y.

DISTRICT REPRESENTATIVES IN THE FOLLOWING CITIES

Birmingham, Ala.
Boston, Mass.
Buffalo, N. Y.
Charlotte, N. C.
Cleveland, Ohio
Dallas, Texas
Denver, Colo.
Detroit, Mich.
Indianapolis, Ind.
Jacksonville, Fla.
North Kansas City, Mo.
Knoxville, Tenn.
Los Angeles, Cal.
Minneapolis, Minn.
Norfolk, Neb.
Norfolk, Va.
Philadelphia, Pa.
Pittsburgh, Pa.
Richmond, Va.
Roanoke, Va.
St. Louis, Mo.
San Francisco, Cal.
Seattle, Wash.
Tampa, Fla.
Washington, D. C.
Honolulu, Hawaii

CANADIAN ASSOCIATE

Canadian Line Materials Limited — Toronto 13, Canada

try SPEER'S combination for Low-Cost commutation

U. S. Pat. 2,181,076

For superior performance in industrial high speed motors, Diesel Electric Generators and Traction Motors, you'll welcome this great carbon brush combination — Speer-patented Multiflex design, plus Speer-developed carbon brush Grade 4029. Brought together in this efficient brush unit are all the economical operating features these two Speer advancements have demonstrated individually for years under actual service conditions.

4029 FOR BETTER COMMUTATION

Rides bounce-free on the commutator • Resists chipping and breaking in rough usage • Acts on commutator as smooth polishing agent • Runs cooler and almost sparkless under high sustained currents and overloads

+

MULTIFLEX FOR GREATER EFFICIENCY

Improves contact • Provides more uniform brush wear • Distributes spring pressure equally • Gives double brush efficiency with single-brush simplicity • Available for any type of commutating machine without special adapters or any change in machine design

4519

Equip *your* machines for better commutation with Speer Multiflex 4029 — brush economy and reduce maintenance problems — cut costs.

Speer

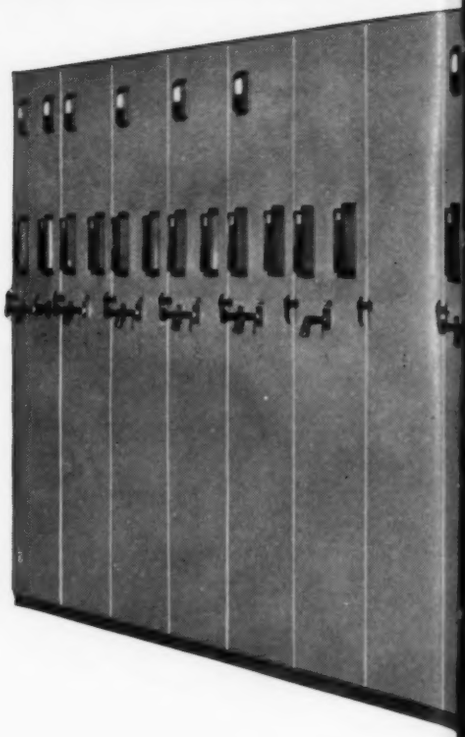
brushes • contacts • welding electrodes • graphite anodes • rheostat discs • packing rings • carbon parts

CHICAGO • CLEVELAND • DETROIT • MILWAUKEE • NEW YORK • PITTSBURGH

CARBON COMPANY
ST. MARYS, PENNA.

Install *AIR BLAST* Metal-Clad

PLAY IT SAFE!



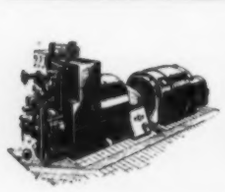
Guard Against Damage to Valuable Mill Equipment • Protect Rolling Mill Motors by Rapid Clearing of Faults • Provide Complete Safety for Your Men • Install Factory-Built, Factory-Wire Allis-Chalmers Metal-Clad Switchgear with *Air Blast* Circuit Breaker

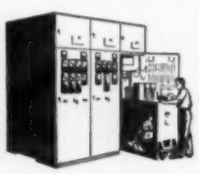
THIS IS THE *ONLY* DRAWOUT VERTICAL LIFT METAL-CLAD SWITCHGEAR equipped with *Air Blast* circuit breakers! That means a space-saving lineup of switchgear that is easily inspected and maintained . . . centralizes power control . . . protects personnel . . . and reduces potential fire hazards.

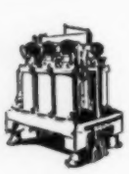
Drawout construction permits ready access to circuit breakers during inspection and maintenance—and interrupting with air blast reduces arcing time to less than a cycle insuring long contact life. *Air Blast* breakers are mechanically strong to withstand repeated "closing-opening" operations. *They consistently complete interruption within four to five cycles.* These 7.5 and 15 kv units have interrupting capacities of 250,000 and 500,000 kva.

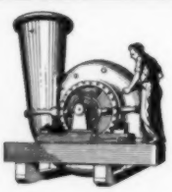
For more information, contact your nearby A-C office, or write for *new* bulletin 18B6760. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

Regulex and *Texrope* are Allis-Chalmers trademarks









POWER & ELECTRICAL — Steam Turbines, Condensers, Water Conditioning, Power Transformers, Switchgear, Unit Substations, Circuit Breakers...

UTILIZATION & PROCESS — Motors, Blowers, Rectifiers, M-G Sets, Ignitron, Pumps, Compressors, *Regulex* Exciters, *Texrope* V-Belt Drives

Switchgear and...

MAINTENANCE IS EASY... FAST... SAFE!

LOWER BREAKER to floor by means of electrically operated motor-lift . . . pull it from structure . . . and roll it away to convenient test stand—that's all it takes! Breaker cannot be lowered when in the closed position because of positive interlocks . . . and automatic shutters prevent accidental contact with live parts — that's added safety for personnel during inspection and maintenance!

A 2360

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products

PLANNING TO USE OXYGEN?

Then You'll Want These Advantages Found Only in—

UNION

DOUBLE-LIFE HEAD CHARGING BOXES

Higher temperatures mean more frequent chargings—both of which put greater stresses and strains on your charging boxes. To head off the cost of losses and replacements change over to the charging boxes that can stand up under this more severe service—UNIVAN. Here's why: All corners are round because square corners do not lend themselves to the casting process . . . Open type head is replaced by our *Double-Life Head* adding strength and rigidity where most needed . . . Middle section of head is further reinforced with 3 ribs adjacent to hook slot . . . Boxes are cast from UNIVAN—that tough nickel-vanadium steel that maintains its strength under wide variations of heat and cold . . . Your request for further details and prices will receive immediate attention.

UNION *Alloy Steel* PEELS

Except for the charge itself, no piece of unprotected metal is subjected to greater heat for a longer time than the peel. And, hot or cold, it must withstand severe shock and stresses as well. "Union" has developed for this tough service peels of heat and shock resistant alloys in designs that add months to their useful life . . . Glad to quote from your specifications on either rough or fully machined castings.

"UNIVAN" Reg. U.S. Pat. Off.

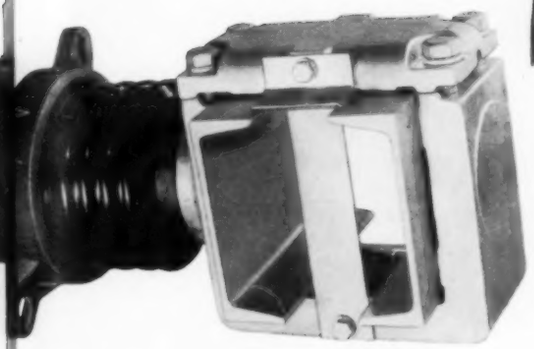
UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

Cinder Pots • Slag Pots • Coupling Boxes • Spindles • Gears • Bells and Hoppers • Ingot Cars • Charging Cars • Annealing Boxes and Bases

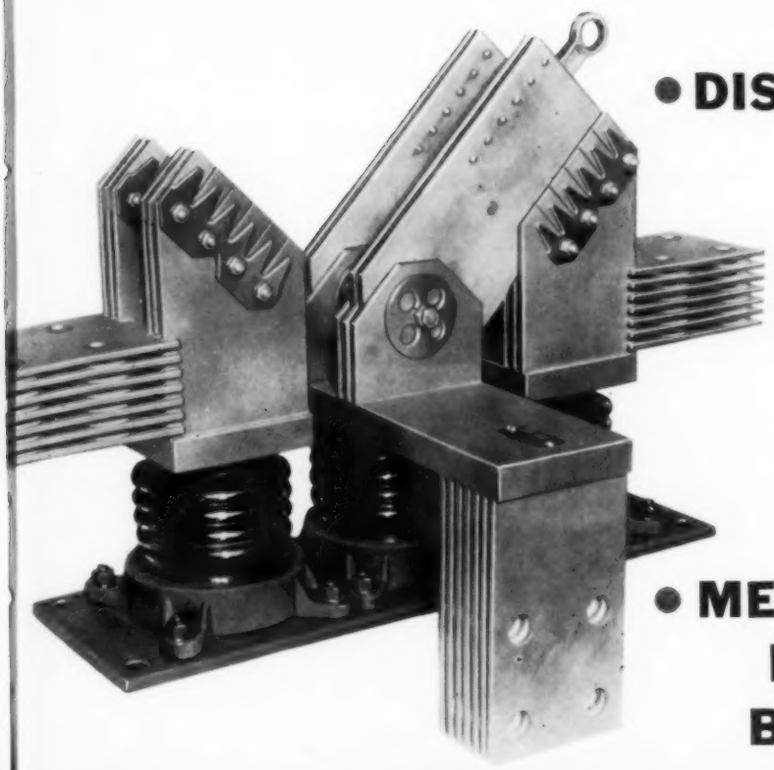
UNION HAS COMPLETE MACHINE SHOP FACILITIES . . . ENABLING THE DELIVERY OF ITS PRODUCTS READY FOR USE

CHECK the FACTS on R&IE



• BUS SUPPORTS

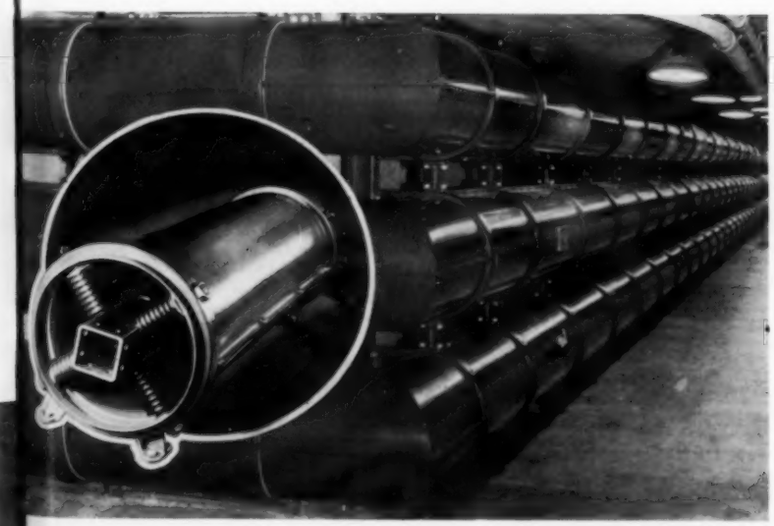
clamping two sections of five inch aluminum channel bus. Also designed for bus bar or cable support. Can be mounted in any position. Bus hardware attached with resilient alloy in place of cement — eliminating spot loading.



• DISCONNECTING SWITCHES --

double throw, 5,000 ampere rating. Blades are equipped with Hi-Pressure Contacts at operating end and at the hinge. Hi-Pressure Contacts make clean and positive electrical and mechanical current connections, and provide easy operation, free from sticking or freezing.

• METAL ENCLOSED ISOLATED PHASE BUS STRUCTURES



have sealed individual housings that prevent interphase short circuit. Support rings, as shown in circle, equalize all stresses. Covers can be removed for inspection or alterations. Especially suitable for heavy bus runs where mill dust and contamination is a problem.

Conductor can be round, square or bar.

Write for further details

RAILWAY AND INDUSTRIAL ENGINEERING CO., Greensburg, Pa.

Sales offices in all principal cities

The Check List

HORN GAP SWITCHES

CONDUCTOR SUPPORTS, CLAMPS AND FITTINGS

DISCONNECTING SWITCHES
INDOOR AND OUTDOOR

INTERRUPTER SWITCHES

CUTOUTS AND THERMO-RUPTERS

DISTRIBUTION EQUIPMENT

SWITCH OPERATING MECHANISMS

SUBSTATIONS

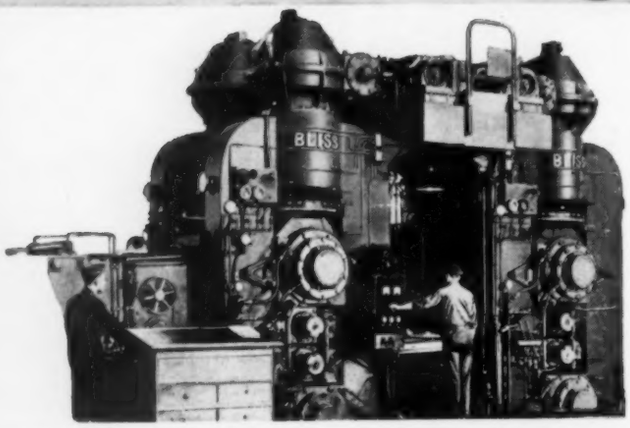
OPEN OR ENCLOSED, ISOLATED PHASE HEAVY DUTY BUSES

KIRK INTERLOCK SYSTEMS

AUTOMATIC SWITCHING EQUIPMENT

METAL CUBICLES

In Rolling Mills, too,

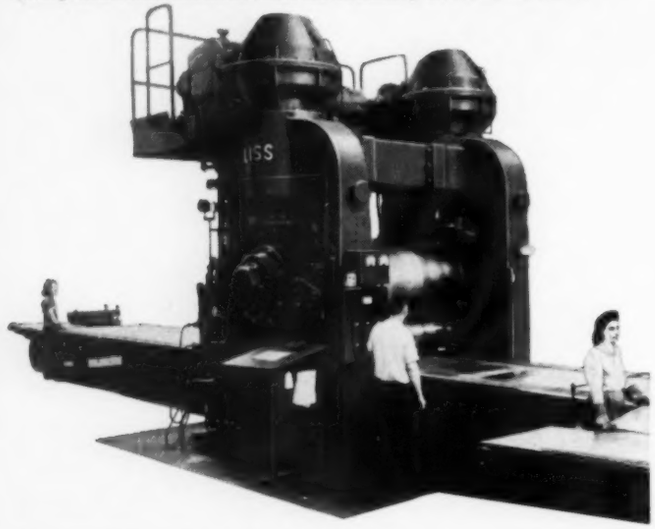


BRASS—16" x 34" x 34" two stand tandem four-high mill is one of many Bliss installations used for breaking down brass slabs.

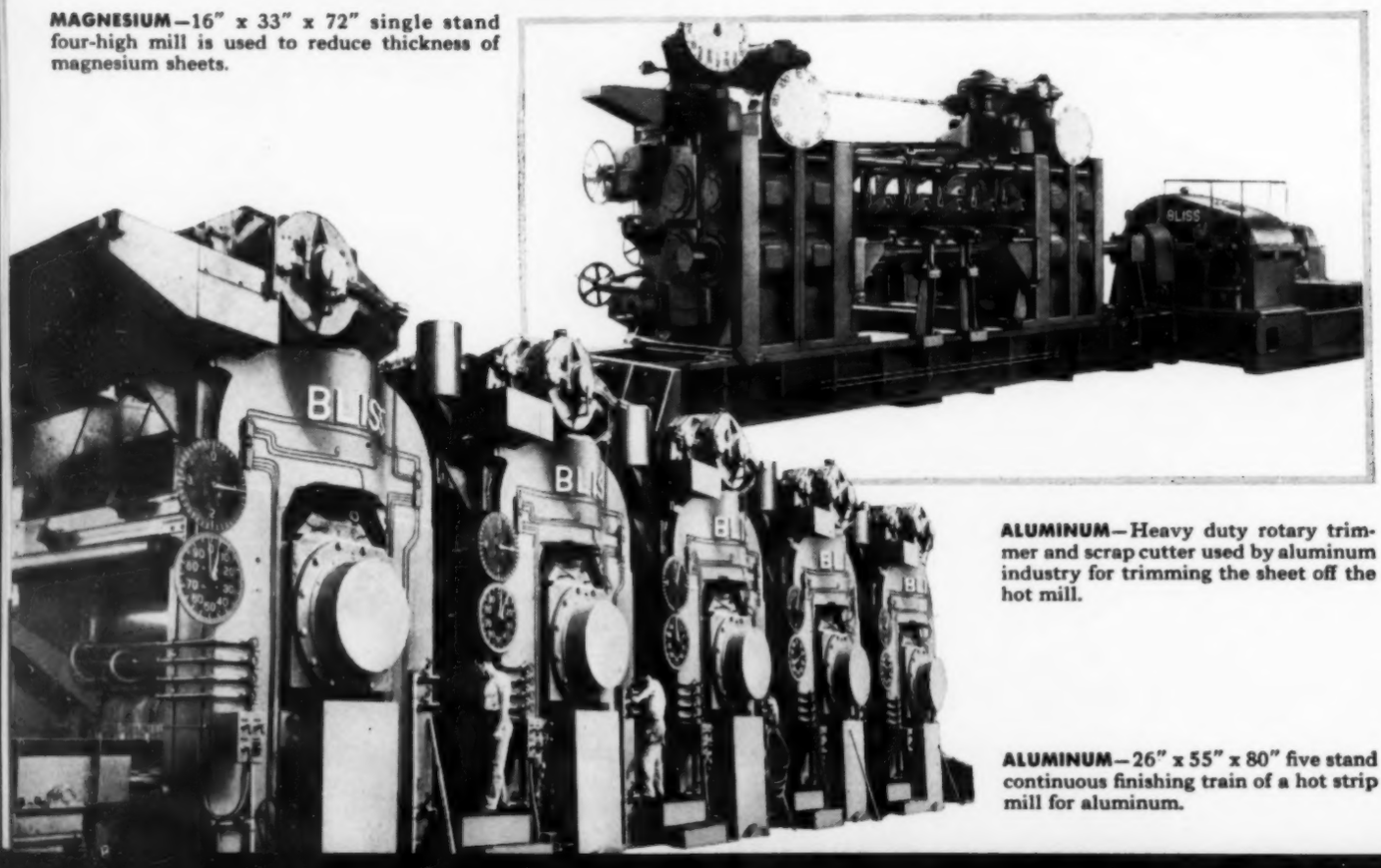
Hundreds of outstanding Bliss sheet and strip mill installations—here and abroad—give daily evidence of the close cooperation between customer and builder which alone can create a mill exactly suited to the job at hand.

Whether your requirements concern 2-, 3-, 4-high or cluster mills; hot or cold-rolling of ferrous or non-ferrous metals, Bliss can supply the equipment especially designed to suit *your* needs. Bliss also builds an extensive variety of accessories: mandrel type hot mill coilers, up-coilers, slitters, etc. Some of this equipment are illustrated on these pages.

Put your rolling mill problem up to Bliss. You'll find the same keen engineering counsel and service which have made Bliss the first name in presses for more than 90 years.



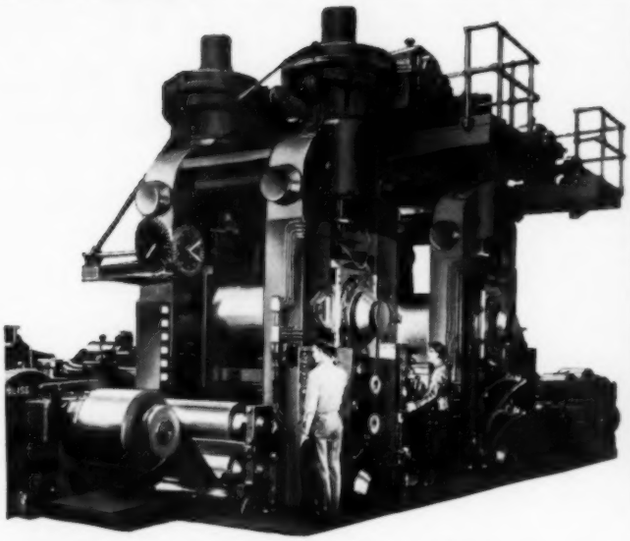
MAGNESIUM—16" x 33" x 72" single stand four-high mill is used to reduce thickness of magnesium sheets.



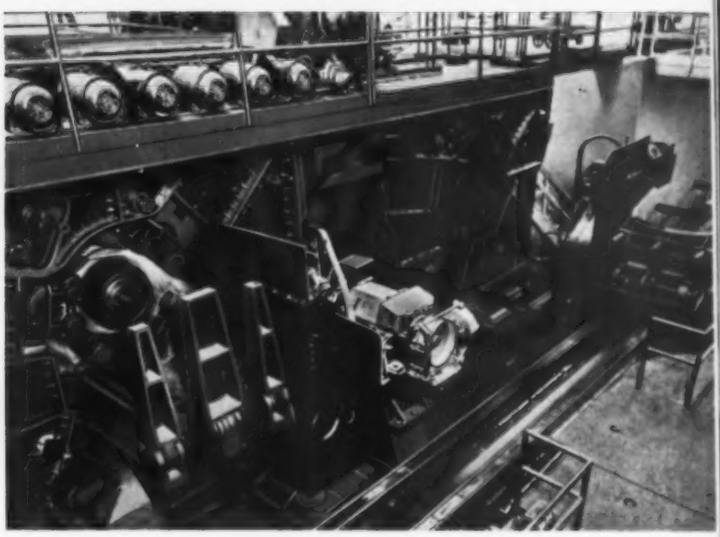
ALUMINUM—Heavy duty rotary trimmer and scrap cutter used by aluminum industry for trimming the sheet off the hot mill.

ALUMINUM—26" x 55" x 80" five stand continuous finishing train of a hot strip mill for aluminum.

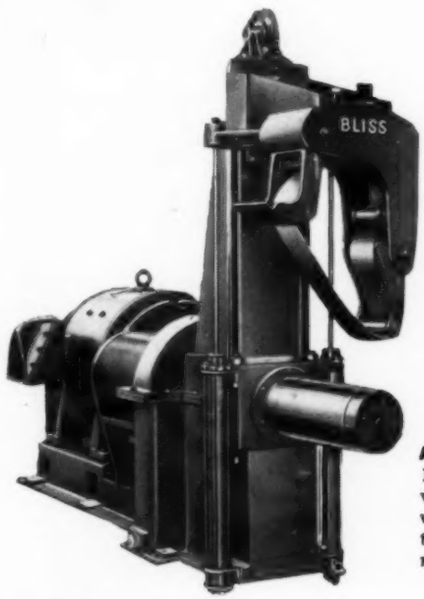
Stay Ahead with Bliss



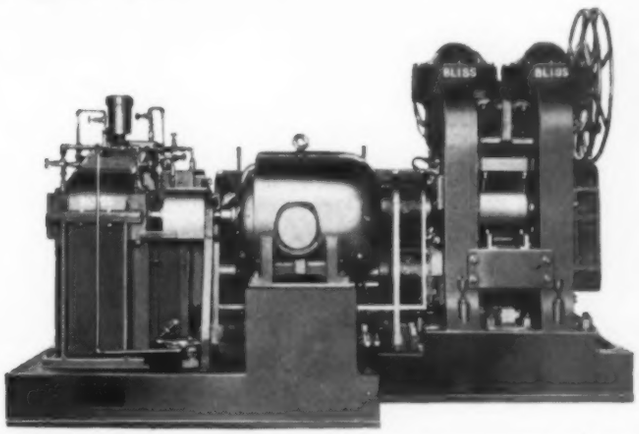
TIN PLATE—18" x 42½" x 42" two stand tandem temper pass mill for tin plate.



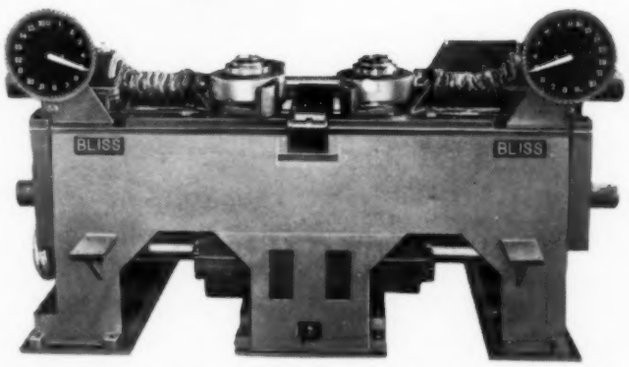
STEEL—Improved type hot strip downcoiler and upender for a Bliss 48" continuous strip mill.



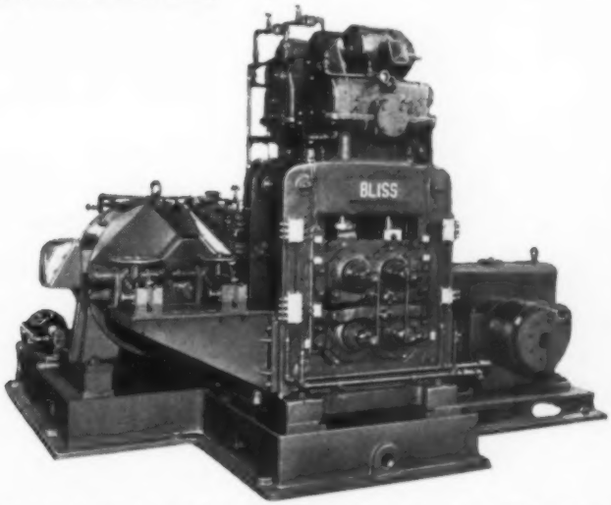
ACCESSORY—12" x 18" tension reel with vertical type belt wrapper has application in ferrous and non-ferrous fields.



COIN METAL—14" x 12" two-high mill used in government mints—typical of smaller Bliss mills.



ACCESSORY—20" Vertical edger for edging 8" to 40" wide slabs.



THIN GAGE METALS—3¼" x 9" x 8" Cluster Mill for cold reducing high carbon alloy and stainless steels from gages of .125" to .004".

E. W. BLISS COMPANY

450 AMSTERDAM AVENUE, DETROIT 2, MICHIGAN

STAY AHEAD WITH *Bliss*

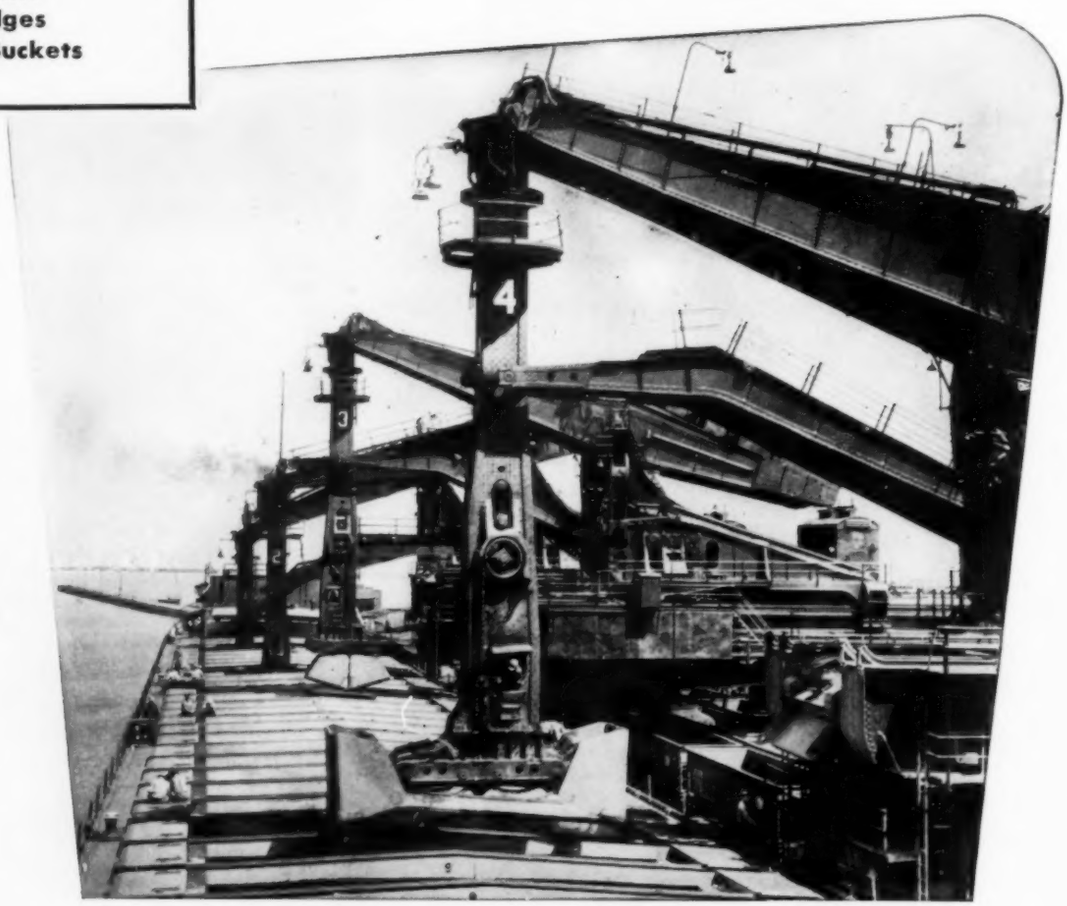
Rolling Mills...Mechanical and Hydraulic Presses Container Machinery

Wellman will build it

Special Cranes
Ore Unloaders
Gas Producer Plants
Charging Machines
Industrial Furnaces
Car Dumpers
Gas Flue Systems
Gas Reversing Valves
Coke Pushers
Mine Hoists
Skip Hoists
Ore Bridges
Clamshell Buckets

Wellman *Hulett-type* Ore Unloaders

Built exclusively by Wellman



• Illustrated are 4 of an installation of 5 of these fast, automatic unloaders in use at one of the largest ore docks on the Great Lakes. Wellman Hulett-type unloaders handle by far the most of all lake-shipped ore. They are a product of Wellman's half century of engineering experience and achievement

THE WELLMAN ENGINEERING COMPANY

7031 CENTRAL AVENUE • CLEVELAND 4, OHIO

Tough Stuff!

Midvale Beta Chisel and Midvale Duredge are as durable a pair of tool steels as you'll find in a day's march. Beta Chisel, while not as hard as Duredge, is very tough. It shines in these roles . . . chisels, shear blades, scarfing tools, rivet busters, and many others. Duredge, on the other hand, is a combination of unusual hardness and toughness, and carries a keen cutting edge under the most severe shock conditions. It measures up to all requirements for pneumatic chisels, beading and caulking tools, rivet sets, moil points, punches, etc. Take your choice and you get custom steel quality . . . Midvale quality.

MIDVALE DUREDGE ALLOY TOOL STEEL

Write for your copy of the Midvale Duredge Alloy Tool Steel folder.

THE MIDVALE COMPANY • NICETOWN • PHILADELPHIA

OFFICES: NEW YORK • CHICAGO • PITTSBURGH
WASHINGTON • CLEVELAND • SAN FRANCISCO

MIDVALE

Custom Steel Makers to Industry

STAINLESS AND TOOL STEEL BARS
•
CORROSION AND HEAT RESISTING CASTINGS
•
FORGINGS AND RINGS

A BATTERY OF —

Wilputte Underjet

coke ovens is a well coordinated implement for the production of better coke at lower costs of fuel, labor and maintenance.

Careful study and development of each and every detail have achieved this result.

Arrangement of the rich fuel gas system in the battery basement

Details of the lean gas and air reversing

Photos by Clare

WILPUTTE

Pusher side of battery of 61 ovens recently completed for the Steel Company of Canada, Ltd., Hamilton, Ontario

Top of battery

Coke side of battery

eversing

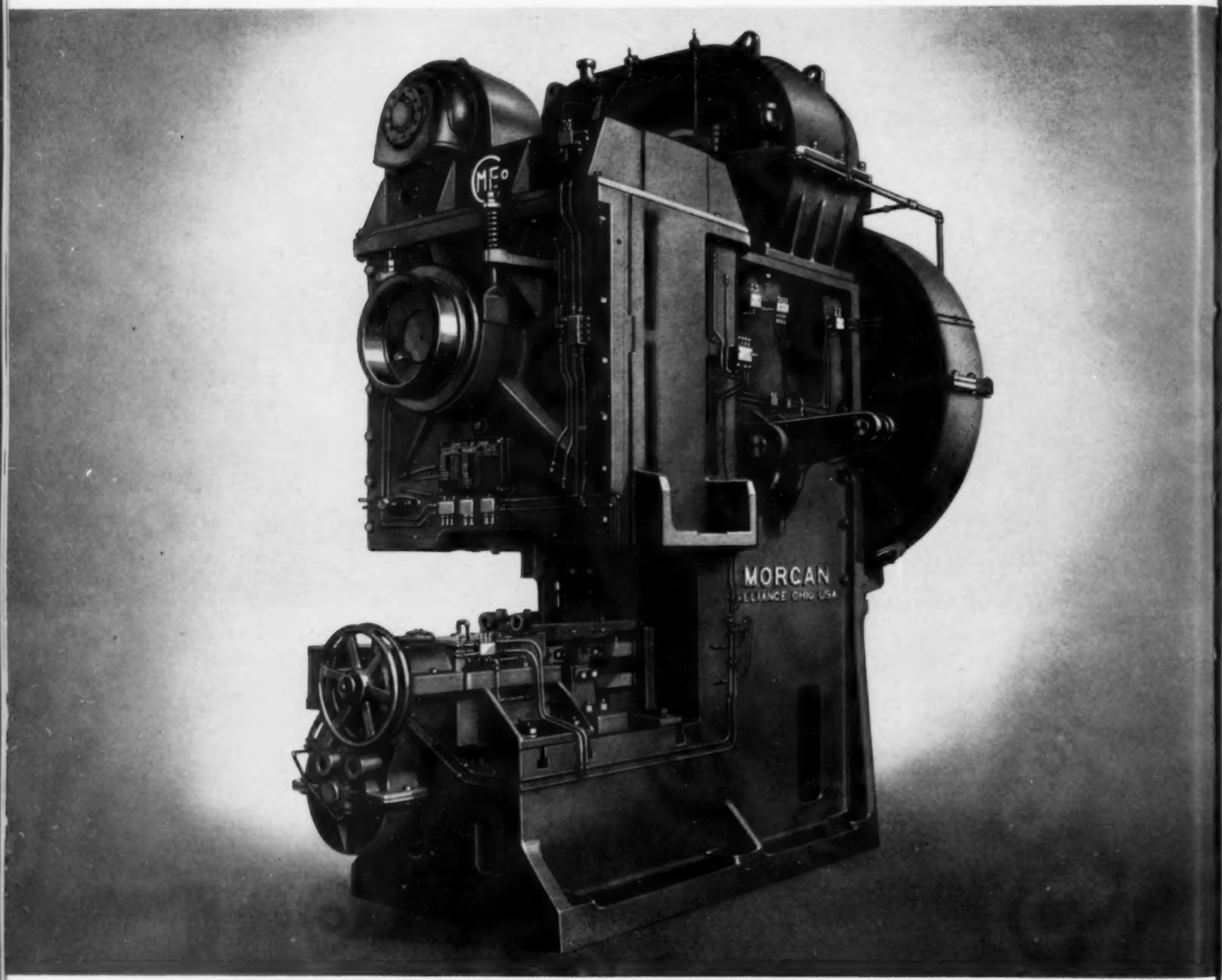
T

OKE OVEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

BUILT BY MORGAN Engineering

MORGAN 600-TON MOTOR DRIVEN STRUCTURAL SHEAR



Illustrated is a Morgan 600-Ton Motor Driven Structural Shear for shearing products from a Morgan 29″ and 23″ Rail and Structural Mill. It will shear up to 4½″ x 4½″ Billets and 4½″ Rounds; Eye Beams and Channels up to 15″; a full line of Angles with equal and unequal legs up to 8″ x 8″; also Fish and Tie Plates.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC

NEWS SUPPLEMENT SEPTEMBER, 1948

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

NEW PLANT FOR REFRACTORIES OF BASIC TYPE STARTS PRODUCTION

▲ In order to supply the growing demand for basic refractories, Harbison-Walker Refractories Company has recently completed a new plant at Baltimore, Maryland, solely for the production of these types of refractories.

In brief, the steps in the manufacturing process are crushing and grinding the individual raw materials, separating each into several grain size fractions, recombining these grains in such proportions as desired, mixing with bonding agents and water, forming the brick at high pressures, and finally maturing the bond either by drying alone, or by drying followed by high temperature firing.

RAW MATERIALS

The ores used in the Baltimore plant are magnesite, chrome ore and olivine. The first of these comes partially from natural magnesite rock from the Northwest Magnesite Company, a partially-owned subsidiary at Chewelah, Washington, and partially from recovery from sea water at the Northwest Magnesite Company's plant at Cape May, New Jersey. All chrome ores are imported, the major sources being Cuba, the Philippines, and South Africa. Olivine occurs in the states of North Carolina and Washington.

BRICKMAKING PROCESSES

All ore is delivered to the plant in hopper bottom cars, and unloaded onto an apron feeder which provides a steady flow of material to the main crusher. A large vibrating car shakeout is used to empty the cars. After the raw material has been crushed in the primary and secondary crushers, it is stored in floor compartments in the raw materials storage building, over thirty different types of raw materials may be stored. Scoop trucks take the ore from these bins to conveyors. Any wet ore is dried in oil-fired rotary dryers and then carried via long conveyor belts to the crushed ore bins. Dry ore is sent directly up the conveyors into the crushed ore bins, and thence to the grinding process.

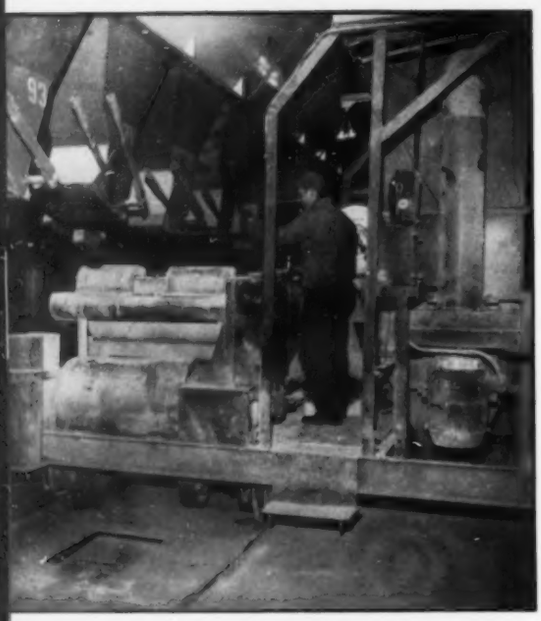
Until the materials are finally blended at the batching larry car, there is a clean separation of all equipment, beginning at the storage building, so as to give separate flow lines for the three materials: magnesite, chrome ore, and clivine. Thus, there are three dry pans, three ball mills, separate dust collector systems, and of course, entirely separate storage bins. This plan eliminates the danger of contamination which might occur when unlike materials are processed through the same equipment.

The dry pans, with removable slotted bottoms having various sized slots to control the size of ground ore, reduce the ore to grains ¼ in. in diameter or less. After grinding, a triple screening process separates these grains according to size, and these are stored in bins. To produce very finely ground material to supplement the product of the dry pan, which by nature possesses a deficiency of finer sizes, ball mills reduce some material to a powder.

There are over 100 elevated storage bins to accommodate the various sizes of each material. These bins are constructed with baffles so as to avoid segregation. The feed to all grinding equipment is automatic and controlled electrically and electronically.

The bins have gates at the bottom for removal of the material, and a larry car moves back and forth on a track beneath the bins while the operator weighs the required amounts of the various materials and sizes into the car hopper, and then sends the batch over conveyors to the mixers. The larry car, which carries its own

Dry pans reduce ore to ¼ in. diameter or less, which is separated according to size. Ball mills are also provided to produce finer material.



The larry car collects the various materials and sizes into its hopper, weighing each item as it gathers the batch.

complete dust collection system, is also used to weigh batches for making refractory cements, mortars, and castables and to feed material into the hoppers feeding the ball mills. Because of the triple screening, the larry car operator has as many as twelve stops in weighing a single brickmaking batch.

The mixers which receive batches from the larry car uniformly combine all the constituents, thoroughly distribute the bonds in the batch. This brick mix is then automatically fed to the mechanical presses which form the brick under a pressure of 5,000 to 10,000 psi. At present there are four 350-ton presses and four 600-ton presses.

From the presses, chemically bonded brick is placed on metal pallets, which are then taken by fork lift truck to the dryer cars which are pushed into the dryers. After drying, the pallets are taken by lift truck to the freight cars where the brick are loaded for shipment. If the brick must be stored, the pallets are piled one above the other and then transferred into the freight cars by lift truck. Thus, the finished brick need only be handled twice unless a palletized shipment is required. If the shipment is to be palletized, the brick are taken from the metal pallets, placed on wooded pallets, strapped in place, and loaded into cars.

Equipment is provided for cutting and forming the metal sheathing which is used in the production of metal-cased brick.

Brick which are to be fired to a very high temperature in the tunnel kiln are set directly on the tunnel kiln car by the press operators. These cars travel through the dryer and the tunnel kiln, and the burned brick, when cool, are removed and stored on wooden pallets. The use of the same car for drying and burning reduces breakage and saves time.

DRYING AND FIRING

Drying and firing operations are greatly advanced over these processes in other plants. The dryers are of hollow wall construction, and strong circulating fans are so placed that the drying air is recirculated a number of times through the product. Air for the dryers is taken from the kiln, and the temperature at the inlet into the dryers is closely controlled.

The Swindell-Dressler tunnel kiln, in which all the burned brick made at this plant are fired, is 324 feet long, has a cross-section area of 8 ft x 9 in., and holds thirty-two kiln cars. The firing cycle can be varied to lend flexibility to this operation. The kiln is oil fired with air atomization at low pressure.

DUST CONTROL

The plant has an extensive dust control system which removes dust from each operation. Since there are entirely separate dust collecting units for magnesite, chrome and olivine, the recovered dust is used as an addition to the brickmaking batch. In addition to the dust collection, a cleaning detail covers the plant each day removing all dirt and trash. This strict cleanliness is necessary to maintain optimum working conditions and to avoid the possibility of contaminating one refractory product with dust from another.

QUALITY CONTROL

Samples are taken at all stages of the brickmaking process and the detailed program of testing and control maintains the high quality so important if refractories are to perform satisfactorily. A complete laboratory, competently staffed, does most of the testing, but some tests are run by the operators at each step along the production line. The tests run at Baltimore are supplemented by others conducted at the company's central research laboratory at Hays, Pittsburgh, Pennsylvania.

The final operation in the plant is the inspection and shipping of the product. This may be in an ordinary freight car, or the brick may be secured to pallets for loading and unloading with a lift truck, or the brick may be crated for overseas shipment from any of the nearby ports.

DESIGN FEATURES

A number of unique features indicate the thought and care exercised by the Harbison-Walker Refractories Company in designing and constructing the Baltimore plant. Its location provides convenient access to the port of Baltimore for water shipment, while good rail facilities are also available.

The storage of only crushed material at the plant lessens, segregation of lumps and fines, and permits all storage under roof. After the materials enter the building, they are continuously under cover until the finished refractories are loaded into cars for shipment.

Insofar as possible, handling has been mechanized, with particular emphasis on conveyors, elevators, and

All burned brick made at the Baltimore plant are fired in this 324 ft Swindell-Dressler tunnel kiln, which holds 32 kiln cars.

Q Is ALUMINUM new as a conductor material?

A It is proved by 50 years' use—on 1,500,000 miles of high lines.

Aluminum conductor means *big* savings, for new installations or rewiring. A 500 circular mil cable with Alcoa E.C.* Aluminum conductor, for example, is less than half the weight of an identical copper cable—and costs far less. Installation is easier and faster because of light weight; transportation costs are less.

Alcoa makes light, strong, conductive E.C. Aluminum; leading wire and cable manufacturers draw, strand, insulate it, and sell it under their own trade marks. They have it now.

ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh 19, Pennsylvania.

*E.C.: *Electrical Conductor* Aluminum

Hydro Station Yard line installed in 1915—still in service.

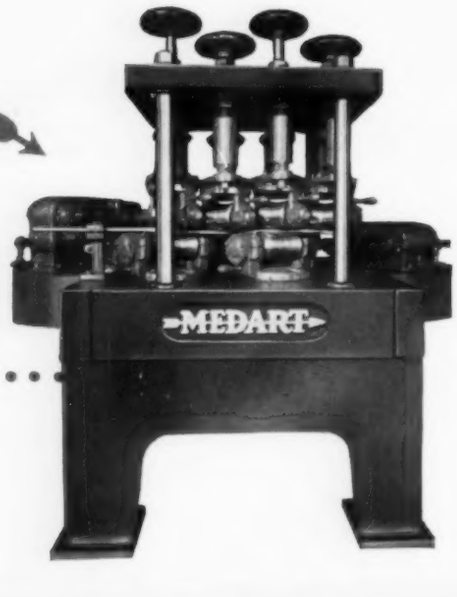
ALCOA EC ALUMINUM

FOR ELECTRIC WIRE AND CABLE

MEDART MICRO-MULTICYCLE!

straightening machine designed exclusively for ⅛" to ½" bars and tubing.

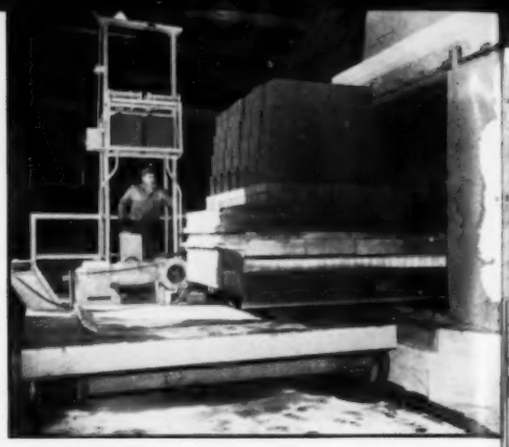
Small, compact yet built on the same principle and embodying the same advantages as the Medart 6-in-1 Multicycle Straightener . . . positive, synchronized feed . . . one feeding level . . . two bending cycles . . . single motor . . . and the Medart Micro-multicycle has this PLUS FEATURE: ali six rolls are driven! A variable feed-speed range is built into the machine. 3 H. P. motor mounted on base of machine.



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY · 3500 DE KALB ST. ST. LOUIS, MO.



Car of burned Chromex B brick being pulled from tunnel kiln.

industrial trucks. Automatic controls have been widely applied. This plant produces approximately 25 different types of basic refractory products.

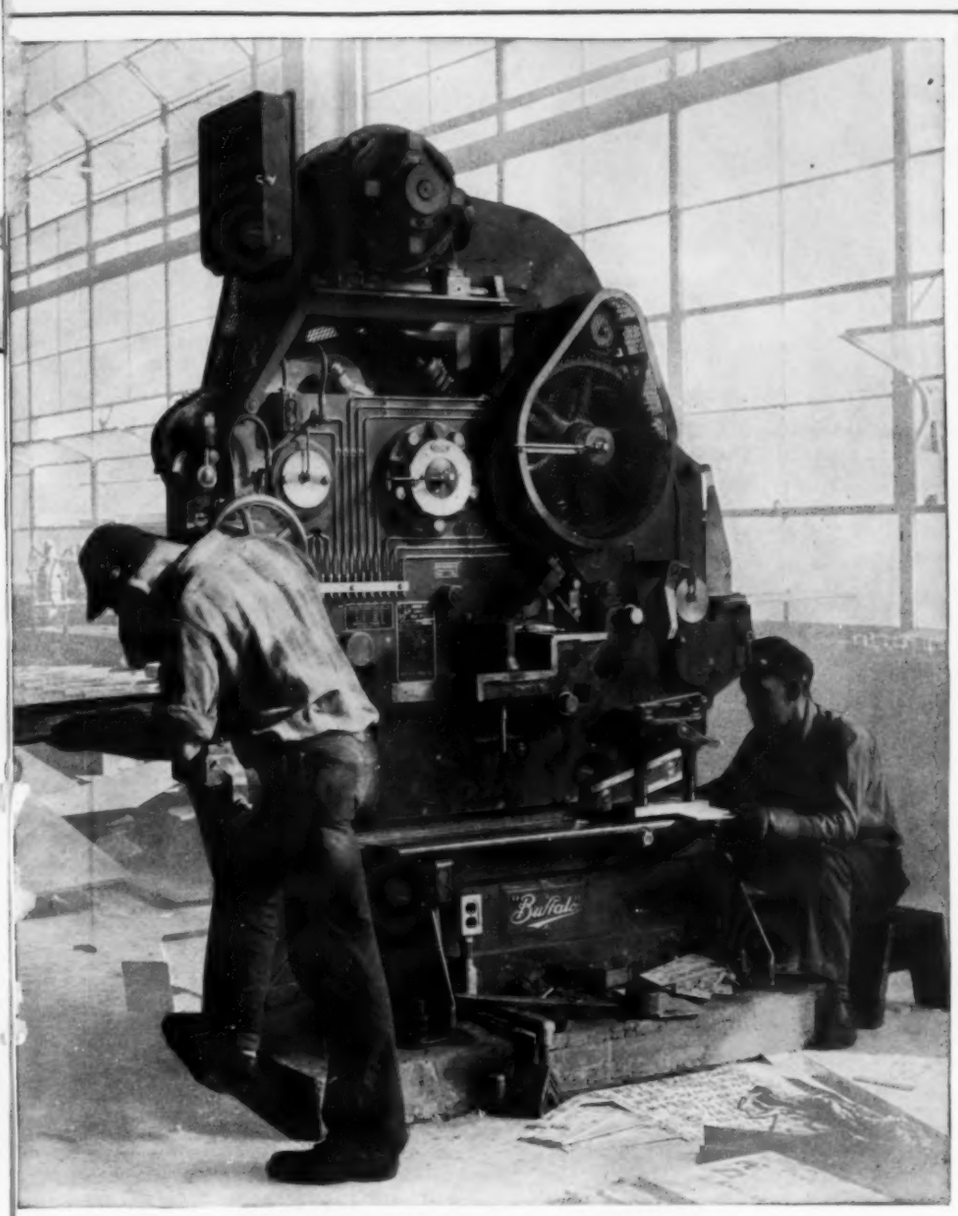
MAGNETIC SWEEPER HAS PERMANENT MAGNET

▲ A new magnetic sweeper, called the "Magna-Sweep," has recently been developed by Dings Magnetic Separator Company. The magnetic sweeper consists of a permanent plate magnet, based on Dings "Perma-Plate" magnet design, which is mounted on wheels for pushing over the floors or ground to pick up iron or steel particles. The sweeper can be used for cleaning up chips in machine shops, picking up nails, tacks, spikes, etc., on loading docks or in truck terminals or parking lots, keeping foundry gangways clean from spills, shot and other iron, and many other places where iron is encountered. It also can be used for reclaiming ferrous scrap, and is capable of picking up 10 to 20 lb of turnings or 40 lb of plate in one load.

The permanent, non-electric magnet used in the Magna-Sweep makes it equally effective on wet or dry surfaces, and the sweeper can be completely submerged. Magnetic permanence is guaranteed for the life of the sweeper.

One prominent feature of the sweeper is its simplicity of operation and cleaning. In operating position, the magnet rests on a horizontal non-magnetic wearing plate to which the iron and steel is attracted and firmly held. To clean, the operator lifts the lever on the handle and the magnet is raised up and away from the wearing plate, allowing the iron to drop off. Sweepers are available in two sizes. The A size is based on a 12 in. magnet and the B size on a 24 in. magnet.

FOR LOWER MANUFACTURING COSTS



"BUFFALO" UNIVERSAL IRONWORKER

MAN-HOUR SAVER *in fabrication!*

● Structural steel shops, shipyards, railway shops, steel mills, other heavy industries, call the "Buffalo" Universal Iron Worker their most useful machine! It cuts, punches, notches, slits or copes angles, tees, flats, rounds, squares, special shapes — with accurate speed that *makes your man-hours count!* Handles three operations at once! Rugged construction for years of 24-hour service! If you want lower fabrication costs, write for the facts on Universal Iron Workers now!

BUFFALO FORGE COMPANY

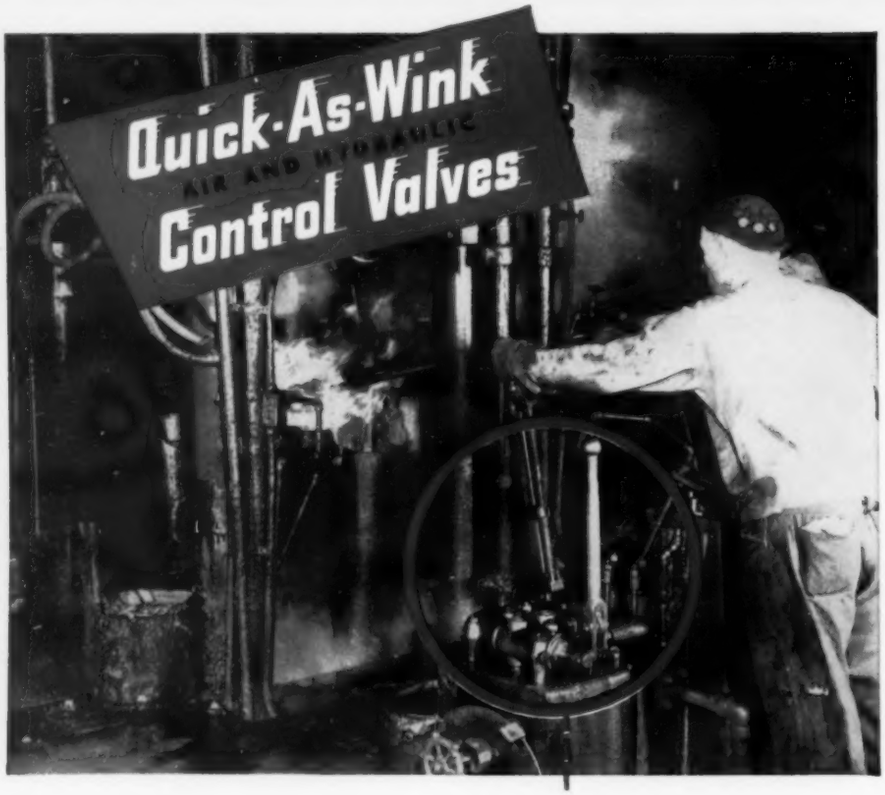
173 MORTIMER STREET BUFFALO 4, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

MACHINE TOOLS by "Buffalo"

- ★ BACK SPOT FACERS
- ★ BAR CUTTERS
- ★ BENDING ROLLS
- ★ BILLET SHEARS
- ★ DOUBLE END PUNCHES AND SHEARS
- ★ LOCOMOTIVE SHEARS
- ★ MILL TYPE SHEARS
- ★ RAPID ACTING PUNCHES
- ★ SINGLE END SHEARS
- ★ SPRUE CUTTERS
- ★ STRUCTURAL IRON WORKERS
- ★ UNIVERSAL IRON WORKERS
- ★ DRILLS FOR THE PRODUCTION LINE DRILLS FOR THE TOOL ROOM

CONTINUOUS SERVICE—FASTER OPERATION—PEAK ACCURACY

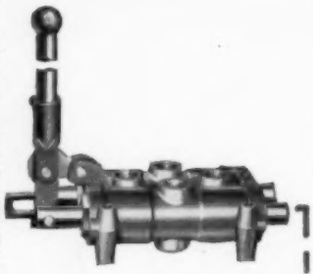


Service built in beneath the surface

● It isn't what you see—but the working parts you can't see that's important about control valves.

Positive and fast acting with U-shaped packers that are expanded by the pressure, Quick-As-Wink Control Valves seal tightly preventing leakage and bleeding. All operating parts are in pressure balance eliminating any tendency to creep or crawl. There is no lapping—no grinding—no metal to metal seating. Every valve is a high quality control—precision made—and individually tested before being shipped. This assures users a maximum of long, efficient, trouble-free service.

Furnished in hand, foot, pilot, solenoid and diaphragm operated designs for controlling all types of air and hydraulic equipment. Let us work with you on your requirements!



Quick-As-Wink Lever Operated Hydraulic Valves

The MF-651-N4 pictured above is a four-way neutral position valve, for controlling double acting cylinders. It can also be furnished with three position "compound-exhaust", or "compound-on" actions. Recommended for use with oil or water up to 150° F. and 2000 PSI. Other types for pressures up to 5000 PSI, — but send for a catalog today and get *full* details about the *complete* line.

Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Manufactured by **C. B. HUNT & SON, Inc.,** *Salem, Ohio.*

Engineering and Sales Representatives in the Principal Cities

J&L SELLS 30 IN. OTIS HOT STRIP MILL

▲ Jones and Laughlin Steel Corporation has sold a 30-in. hot strip mill at the Otis works, Cleveland, Ohio, to Alan Wood Steel Company of Conshohocken, Pennsylvania.

Alan Wood Steel Company will take possession of the Otis 30-in. hot strip mill after October 1. The mill equipment will be dismantled, rebuilt, and moved to Conshohocken, Pennsylvania.

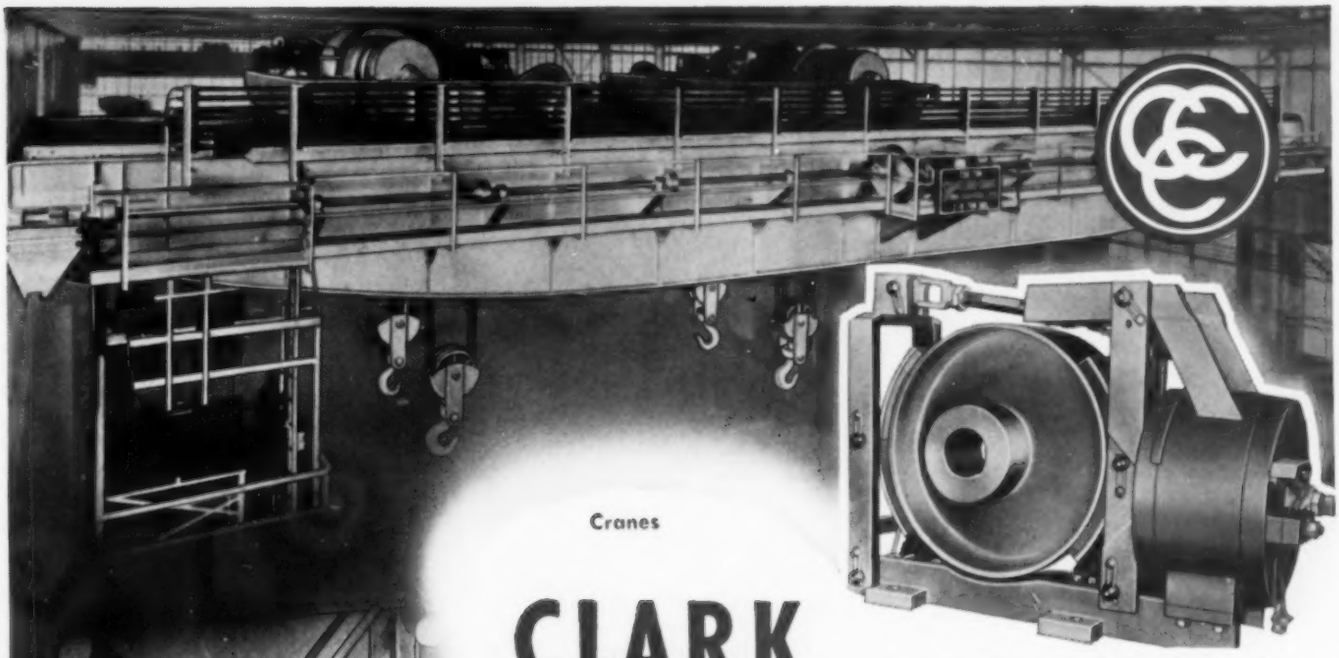
Progress in J & L's $12,700,000 program to improve other hot rolling facilities at the Otis works has enabled disposal of the mill.

After September 30, the Otis 77-in. hot strip mill, now undergoing remodeling, will roll all steel produced at the J & L Cleveland plant.

J & L's improvement of hot rolling facilities at Otis will separate the blooming mill from the 77-in. hot strip mill. Installation of new facilities in the blooming mill and the 77-

RADIAGRAPH CUTS MOLD TO CHARGING BOX SIZE

It's not every day a customer wants you to reduce a 48-ton ingot mold to charging box size — but that's what was asked of a prominent Pacific Northwest ironworks recently. To further complicate the job, the location of the cast-iron mold required that it be halved where it lay. Although it wasn't the usual way of doing the job, the ironworks' engineers decided on machine gas cutting using an Airco radiagraph with a heavy-duty, water-cooled torch. Then, using a 2½-in. square billet as a waster, the radiagraph was started at a speed of 1½ in. per min. Fire clay was packed on both sides of the billet to keep the molten steel in the kerf. The oxyacetylene flame slashed through the 15-in. thick casting and the 2½ in. waster at a speed that required only 96 minutes to make the 12-ft-long cut.



Cranes

CLARK

Clark Bulletin 106 D. C. Shoe Brake

BULLETIN 106 DC BRAKES

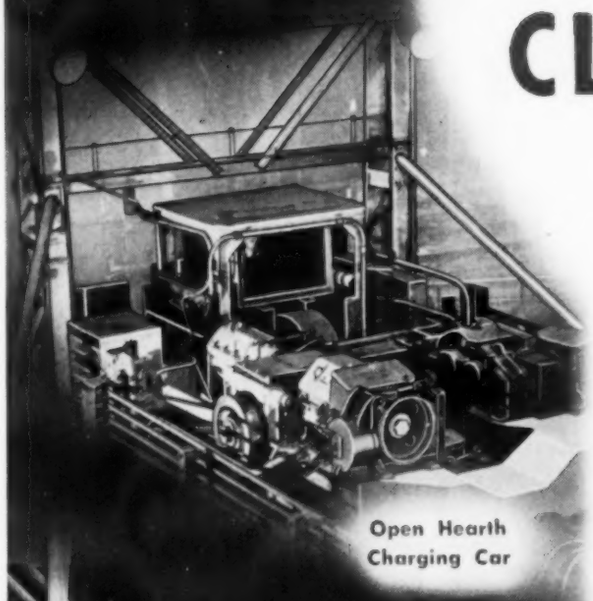
For Every Heavy-Duty Mill Application

● These brakes are making records daily in many heavy-duty, tough mill applications. They give complete satisfaction, with minimum maintenance.

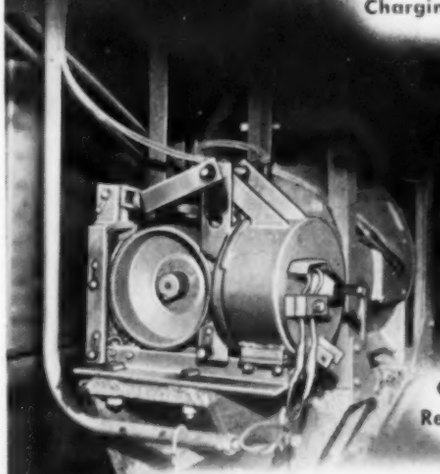
After installation there is only ONE adjustment, and that's for lining wear.

And that adjustment is on TOP! Not on the sides; not on the ends; not on the bottom, but on TOP, where you can see it and get at it easily.

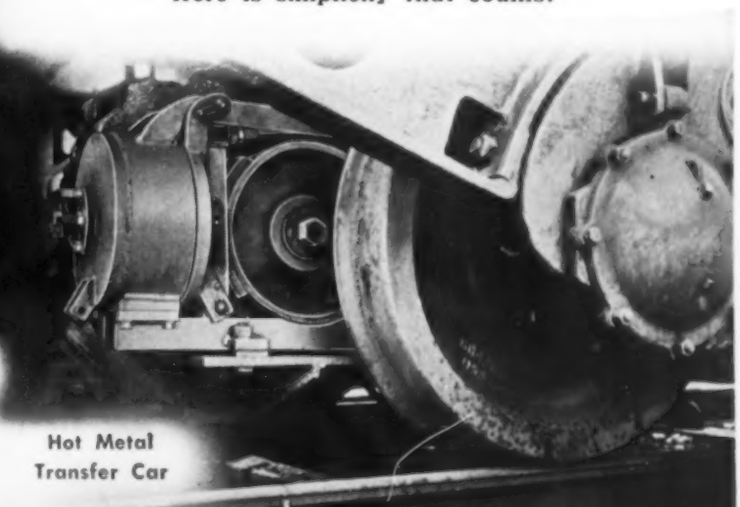
Here is simplicity that counts!



Open Hearth Charging Car



Open Hearth Reversing Valve

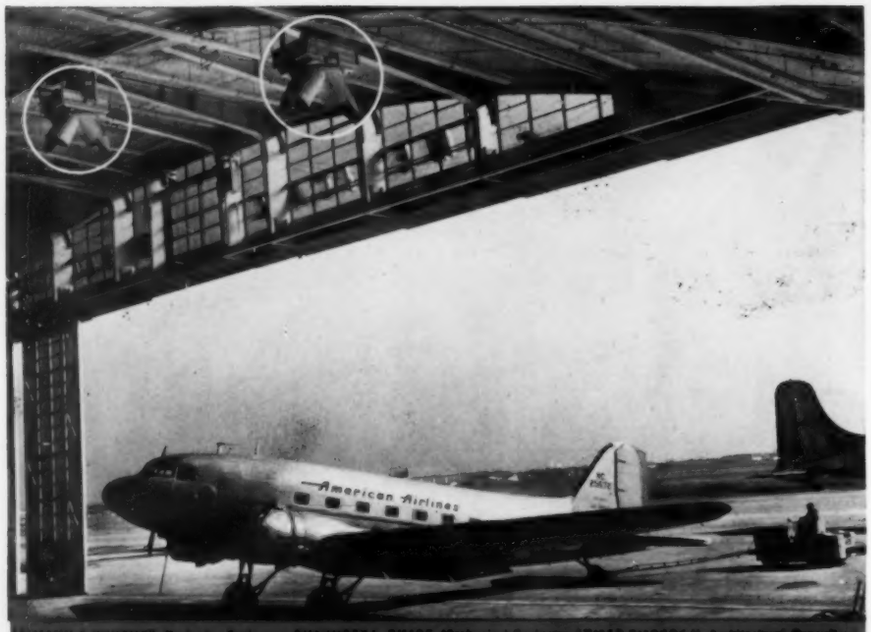


Hot Metal Transfer Car

Consult our nearest Representative to solve your braking problems

THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO



Largest Commercial Aviation Hangar in U. S. Heated with Wing Revolving Heaters

The Wing Revolving Discharge Outlets turn slowly through a complete circle about once every two minutes, affording complete coverage, avoiding concentrated blasts of air and providing a pleasant, healthful working atmosphere.

The new American Airlines hangar at Chicago, consisting of two units, each 257 feet wide, with door openings 235 feet x 41 feet high, presented a heating problem of unusual proportions.

This problem was solved by the installation of sixteen Wing Revolving Unit Heaters—eight in each building. Because of their unique revolving discharge outlets, they keep the heated air continually moving, circulating around and under the planes and keeping a constantly renewed blanket of warm air clear down to the ground. Only by this means can the heat pass the barrier presented by the huge wings and broad fuselages of giant airliners parked in the hangar. Only by this means can the influx of cold air from the 41-foot doors be counteracted.

Factory owners and managers with heating problems can well be guided by the judgment that solved this immense problem of heating. Write for descriptive bulletin or specific details.

L. J. Wing Mfg. Co. 142 West 14th Street, New York 11, N. Y.

Factories: Newark, N. J. and Montreal, Canada

Wing

Revolving

UNIT HEATERS

in. strip mill will streamline production and improve quality.

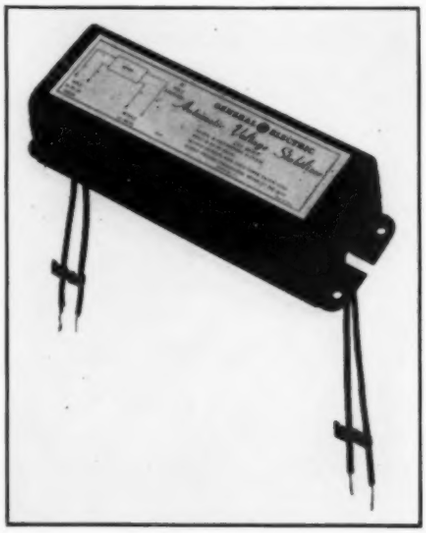
Included in the program and now in the process of construction are: (1) Improvement of steel slab handling and storage facilities. (2) Installation of new slab shear and transfer table. (3) Construction of three new reheating furnaces and furnace delivery table. (4) Installation of a new four-high roughing stand and hydraulic spray system. (5) Extension of the mill building and installation of new coilers and coil conveyors. (6) Relocation of trackage and skull breaking yard.

Construction on the project began in September, 1947, and is scheduled for completion late in 1949.

RECTIFIER STACKS ARE OIL-IMMERSED

▲ Wider use of all rectifier equipment has been made possible through the introduction by the General Electric Company of a new line of oil-immersed selenium rectifier stacks.

Isolation from dampness and corrosive vapors, greater short-time overload due to increased thermal storage, protection from physical

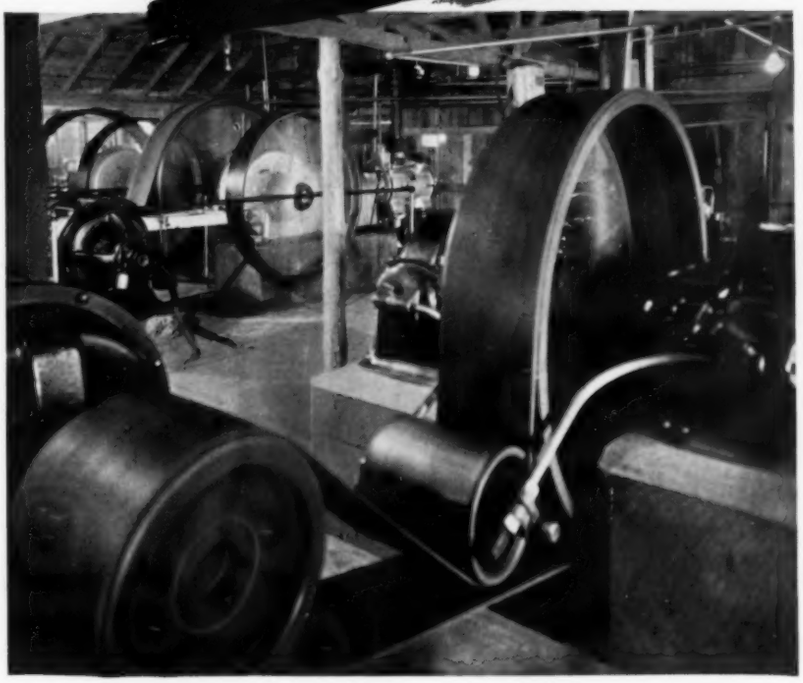


damage while in storage or during assembly and large selection of ratings are features of the rectifiers.

The oil acts as an effective cooling medium and the container, which has a protective coating, resists the effects of moisture, fungus, salt air and other corrosive vapors.

Insulated solder lugs on one end of the rectifier provide easy, quicker soldering connections. Brackets are available for mounting of the units.

CUT TOMORROW'S SHUTDOWNS TODAY



Whenever wiring jobs come up, think beyond today's wiring needs—think in terms of cutting costly shutdowns—think in terms of maintenance-saving, time-saving Deltabeston* wires and cables. Make it a habit, wherever heat's a threat, to specify Deltabeston throughout, because Deltabeston wires and cables are made specifically to combat the effects of heat, moisture, and corrosive vapors; they give electrical systems protection from immediate hazards, and an extra margin of protection to cover future, unanticipated needs.

So whether you're rewiring an existing system or installing a system in new construction, don't overlook heat-beating Deltabeston. The Deltabeston line includes standards and "specials" for every combination of heat, moisture, corrosive vapor, or other conditions—for temperatures up to 200 C. It gives the system extra protection both on hot jobs and on ordinary installations. And, men who know your problems stand back of your Deltabeston supply source ready to advise you on selection.

For full information on Deltabeston, write to Section Y26-946, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

*TRADE-MARK REG. U. S. PAT. OFF.

GENERAL ELECTRIC

HI-AMBIENTS

Application hints on the complete Deltabeston line

FLEXIBLE HINGE CABLE for swinging panel connections and general switchboard work is available in the Deltabeston Switchboard Wire and Bus Cable line. Insulated with felted asbestos and covered with cotton braid with flame-resistant finish, it is essential for wiring switchboards up to 90 C (194 F).

SPREADING OUT. Originally designed for infrared oven use, silicone-treated Deltabeston cables proved so successful that now they're being used for both 300- and 600-volt service on many extra-high heat applications. On jobs where the temperature goes as high as 200 C (392 F), specify silicone-treated Deltabeston.

MOISTURE RESISTANCE is only one of many advantages Deltabeston power cable offers you. Like all Deltabeston products, it's a heat beater because it's insulated with purified asbestos. Varnished cambric and heavy braid or lead sheath help resist abrasion, flame, grease, corrosive vapors, and oil.

SIMPLIFIES SELECTION. To help in the selection of the proper Deltabeston magnet wires for the jobs you've got to do, General Electric has prepared the *Deltabeston Magnet Wire Booklet.* This handy guide contains facts on the many kinds of magnet wire made by General Electric, and includes a handy specification chart to make selection easy. For your free copy, write to Section Y26-946, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

DELTABESTON
Wires and Cables
Built to beat the heat

"MULTICUT" "TUFCUT" "HOT WORK"

Wapakoneta
SHEAR BLADES
and ROTARY KNIVES

Any type or size blade of proper Alloy with correct hardness and temper for every type shearing machine and every kind of job.

Rx ENGINEERED TO THE JOB

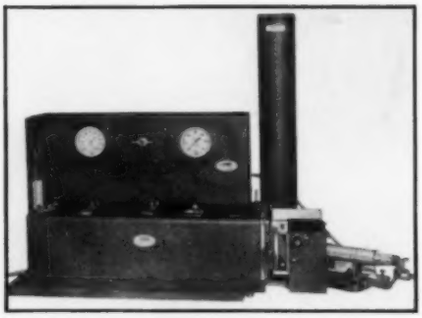
Every Wapakoneta blade is made to exact specifications, designed for the particular job. Complete records with order number of each blade makes possible duplication of exact size and temper at any time.

The
WAPAKONETA MACHINE CO.
Shear Blade Specialists Since 1891
Wapakoneta, Ohio

SPECTROPHOTOMETER USES HOT FLAME

▲ A Beckman flame spectrophotometer has recently been announced by National Technical Laboratories, manufacturers of Beckman pH meters, Beckman radiation meters and other well-known instruments. The new unit greatly simplifies both qualitative and quantitative analyses of a large number of chemical elements, and its use of a hot flame is of particular value since it permits excitation of the spectral lines of a large number of elements, including many of the heavy metals and alkaline earths, whereas a cool flame instrument excites only those of the alkali metals. Its wide spectral range, covering the ultraviolet, visible and near infrared spectral regions, insures maximum range and versatility.

The method is adaptable to a variety of analytical problems including water analyses, metal and ore analyses, determination of inorganic traces and impurities in foods, chemicals, biologicals, pharmaceuticals and inorganic materials which can be reduced to inorganic solutions.

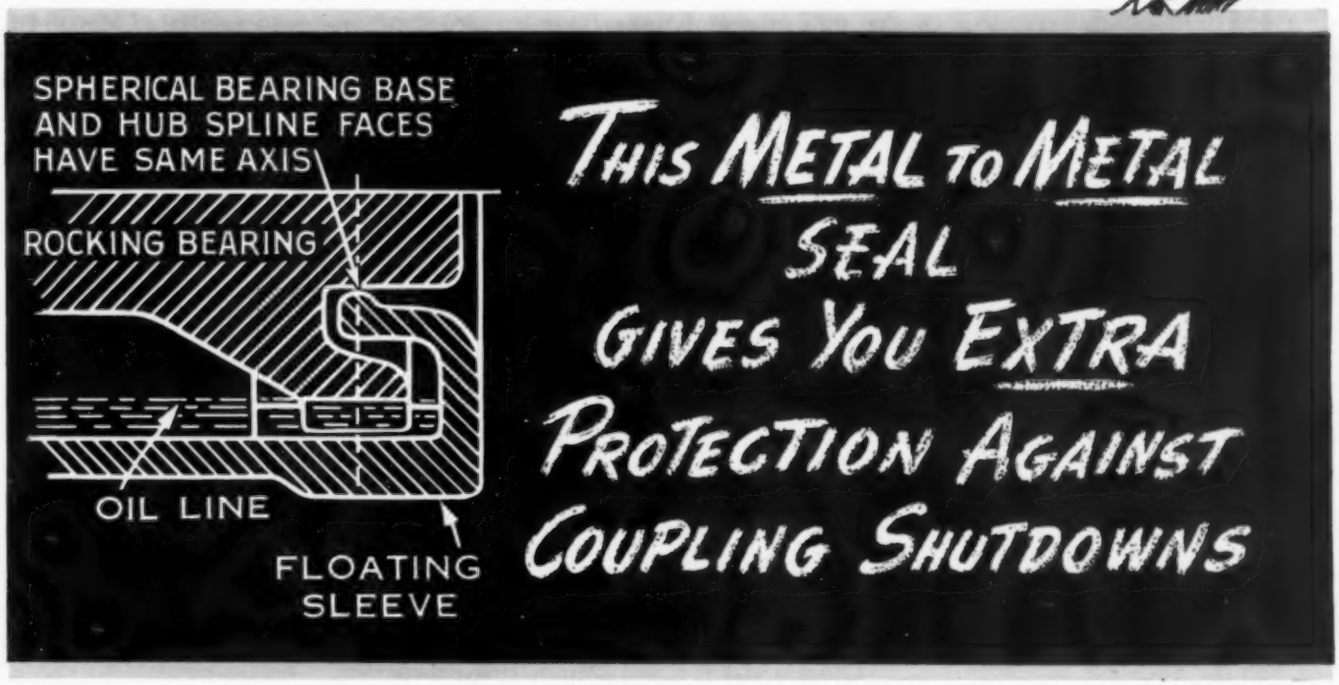


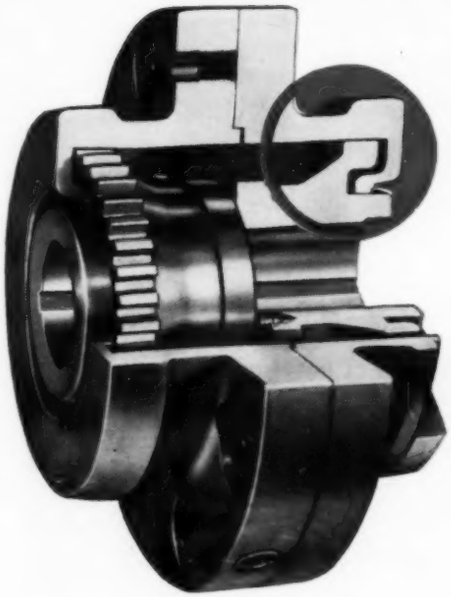
Three interchangeable sprayers are connected to the burner at all times so that atomized spray may be introduced into the flame.

Samples are atomized and introduced at a uniform rate into a very hot oxygen and gas flame through a specially designed burner. The spectral emission lines of the elements are excited and the spectrophotometer isolates these lines and measures their intensities relative to a blank or standard.

Only small samples are required, and because the samples are atomized directly from external beakers, samples can be analyzed very rapidly. A rate of four samples per minute is easily maintained — and rechecks

What's the BIG IDEA in Fast's Couplings?


SPHERICAL BEARING BASE AND HUB SPLINE FACES HAVE SAME AXIS
ROCKING BEARING
OIL LINE
FLOATING SLEEVE
THIS METAL TO METAL SEAL GIVES YOU EXTRA PROTECTION AGAINST COUPLING SHUTDOWNS



YOU can forget about coupling shutdowns once you've installed all-steel Fast's self-aligning Couplings in your plant. There's nothing to wear, nothing to fail in a Fast's. Even the load-carrying oil is protected by an exclusive "rocking bearing" (shown in circle). This bearing is *exclusive* in providing a positive metal-to-metal seal against wear-producing moisture, dust and grit. The bearing is also exclusive in its correctly engineered position which allows *freedom of movement* to compensate for misalignment because its *spherical* base has *the same axis* as the hub spline faces. No perishable packing rings are used. That's the "big idea" that helps Fast's Couplings give you uninterrupted power transmission!

We have a complete line of couplings for immediate delivery. When you buy any one of them, you buy years of top engineering experience, Koppers' high standard of workmanship and unexcelled coupling service that assures a ready source of spare parts, no matter how old your couplings may be. Result: longer machine life, lower upkeep costs, minimum shutdown losses. For full information on Fast's, the *original* gear-type coupling, fill out the coupon below and mail it to: Koppers Co., Inc., Fast's Coupling Dept., 219 Scott St., Baltimore 3, Maryland.

K KOPPERS

FAST'S *self-aligning* COUPLINGS

SEND FOR FREE CATALOG giving detailed descriptions, engineering drawings, dimension and capacity tables, and typical installation photographs for the many types of Fast's Couplings. Fill out this coupon and mail it to: Koppers Co., Inc., Fast's Coupling Dept., 219 Scott St., Baltimore 3, Md.

Name..... Position.....

Company.....

Street..... City..... State.....

WATER HAMMER

can cost

a Fortune

yet it costs so little to correct with

THE WILLIAMS-HAGER *flanged* SILENT CHECK VALVE

Used and specified on hundreds of new buildings—and installed on thousands of old buildings to prevent costly "Water Hammer"—the Williams-Hager Flanged Silent Check Valve will solve your problem, too! Write for new technical bulletin.

THE WILLIAMS GAUGE CO.

Pump Valves . . . Water Gauges . . . Gauge Cocks . . . Steam Traps . . . Pump Governors . . . Feed Water Regulators . . . Water Columns

3076 PENNSYLVANIA AVE. · PITTSBURGH (12), PA.

against blanks can be quickly made at any time. Results are instantly and directly readable on an accurately-calibrated dial. No photographic processes or densitometer comparisons are necessary.

Three interchangeable sprayers are connected to the burner at all times so that atomized spray from any of them may be instantly introduced into the flame. Thus, two unknown samples and a standard or blank—or one unknown and two standards—may be rapidly and interchangeably studied.

PUSH COKE AT LARGE COKE OVEN BATTERY

▲ First coke has been pushed from No. 1 battery of 106 coke ovens at the Aliquippa works of Jones and Laughlin Steel Corporation. Built by Koppers Company, it is one of the largest coke oven batteries in the world, and the second one of this size to go into operation at Aliquippa during the past three years.

Constructed at a cost of more than $12,000,000, the new ovens will produce 53,350 tons of coke per month for the Aliquippa blast furnaces.

Completion of the No. 1 battery, which replaces the original battery of 61 ovens, will give the Aliquippa works a total capacity of 145,000 tons of blast furnace coke per month.

No. 1 battery is similar to No. 4 battery, which was put into operation in December 1945 and was at that time the largest in the world To date it has been equalled but not surpassed.

Over 77,000 tons of coal will be required per month to be processed in the new installation, bringing the total coal requirements for the Aliquippa coke plant to over 200,000 tons per month.

In addition to the blast furnace coke, the new ovens will yield many by-products, including fuel for boilers, gas, benzol products, tar, ammonium sulphate for fertilizer, pyridine and other chemicals.

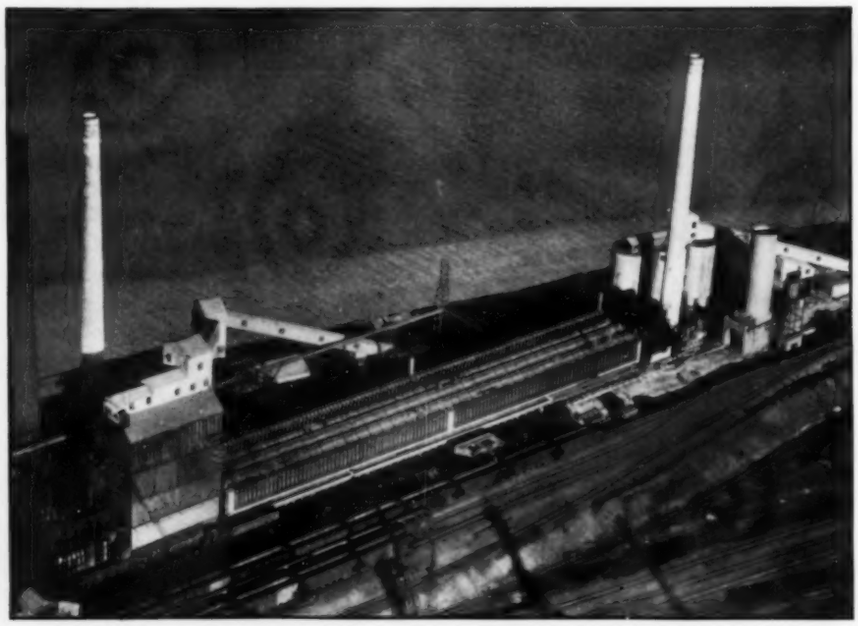
Over 2¼ billion cu ft of gas, used mainly in reheating furnaces throughout the Aliquippa works, will be produced per month in the coke plant Of this amount, the new ovens will produce over 810 million cubic feet per month.

In one month the new ovens will contribute 231,000 gallons to the total output of 600,000 gallons of benzol at Aliquippa. Benzol is used by manufacturers for nylon stockings, paint, and chemical products.

The coke plant will also produce 2 million gallons of tar per month, 730,000 gallons of which will come from the new ovens.

Completion of the new ovens marks another forward step in the $107,000,000 expansion and improvement program underway throughout the Jones and Laughlin Steel Corporation.

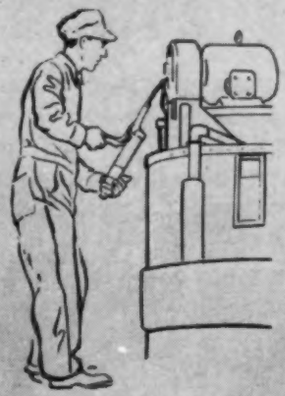
Constructed at a cost of over $12,000,000, the new ovens will produce 53,350 tons of coke per month for the Aliquippa blast furnaces.



Better your "Break-Even" point...

from drum to filler pump 1

from filler pump to grease gun 2



from grease gun to fittings 3

LINCOLN

Complete Original Container to Bearing

LUBRICATING METHODS

cut maintenance time!

boost production time!

Engineered lubrication, the Lincoln Way, helps increase plant efficiency. It cuts maintenance time by providing a speedy method of transferring and applying lubricants. It minimizes down-time, caused by bearing failure—valuable time that can be used to boost production.

To make sure that lubrication is on a par with other vital maintenance factors, install a Complete Lincoln Original Container to Bearing System and improve your "break-even" position.

ask your wholesale distributor!

Your Lincoln Distributor will gladly show you the lubricating equipment you need for top efficiency. Ask him for a copy of Lincoln Catalog No. 63. Consult him or any of the Lincoln branches listed below for help in solving your lubrication problems.

SALES AND SERVICE OFFICES

BOSTON—H. G. Davis, Inc.—Kenmore 5176
BRIDGEPORT—H. G. Davis, Inc.—Bridgeport 5-8160
CHICAGO—Lincoln Engineering Co. of Ill.—Calumet 6022
CLEVELAND—Lincoln Lubricating Systems, Inc.—Express 4334
DETROIT—Lincoln Engineering Co.—Madison 3484
EAST ORANGE—Lincoln Lubricating Systems, Inc.—Orange 3-3188
FORT WORTH—Fritz Keller—2-1345
LOS ANGELES—Lincoln Engineering Co. of Calif.—Richmond 0151
MILWAUKEE—Lincoln Equipment Service—Division 1191
NEW YORK—Lincoln Lubricating Systems, Inc.—Trafalgar 7-7900
OAKLAND—Lincoln Engineering Co. of Calif.—Higate 6130
PHILADELPHIA—Lincoln Engineering Co.—Locust 4-3877
PITTSBURGH—Lincoln Engineering Co.—Montrose 1444
PORTLAND—Pioneer Equipment Company—Lancaster 0488

● *Apply the right lubricant* ● *In the right quantity* ● *At the right time!*

Lincoln is the originator of the Kleenseal Surface Check Grease Fitting—the new, modern fitting with the ball in the top.

LINCOLN

LINCOLN ENGINEERING COMPANY

Leaders in Lubricating Equipment for a Quarter Century

5701 NATURAL BRIDGE AVE., ST. LOUIS 20, MO.

848 22

ROLL TURNER'S HELPER INSURES UNIFORM FEED

▲ A roll lathe automatic tool feed or "roll turner's helper," which insures a uniform and exact rate of tool feed, has recently been developed and placed on the market by United Engineering and Foundry Company.

Known as "Rollafeed," the new unit is portable and designed for easy attachment to the tool rests of new or existing roll lathes. "Rollafeed" pushes the tool into the work in exactly the same manner as it is done by the roll turner and utilizes the same tools, wedges, supports, etc. The total weight of each unit is approximately 110 lb, which permits easy shifting for repositioning.

The feeding mechanism is actuated by air pulsations from existing mill air supply which are controlled by a headstock driven cam. The desired rate of feed is selected from a range of ten steps built into the unit. Provision is made for throwing the automatic feed out of engagement to permit the operator to feed the tool by hand, if desired, when approaching final dimensions. Units may be used in multiple and operated as closely as 9 in. center dimensions.

The new unit is portable and is designed for easy attachment.

Actual time studies show as much as 48 per cent savings in roll turning time.

For accurate regulation of liquid flow
Announcing
a new, smaller capacity
maximum capacity 150 gal. per hour
BLOOM Constant Flow OIL VALVE
The design of this constant flow oil valve is based upon the similar Bloom Valve of larger capacity which has proved so successful in service. With this valve, a uniform flow of oil is assured at any dial setting, regardless of fluctuations in pressure. Made in following capacity sizes: 25 gph, 50 gph, 75 gph, 100 gph, 125 gph and 150 gph. Write for complete details.
BLOOM
ENGINEERING CO., INC.
857 W. North Avenue
Pittsburgh 12, Pa.

NEW NON-FERROUS MILL IS ONE OF THE LARGEST

▲ Progress on the extensive addition to the rolling mill of the Scovill Manufacturing Company, Waterbury, Connecticut, indicates completion by the end of the year of this new building occupying about four acres of space. When it is finished, the company will have in operation one of the fastest and most efficient nonferrous mills in the country for cold rolling of copper base alloys in sheet and strip form.

The building is one story with continuous steel frame supported on soil-bearing the new building in such close proximity to the existing mill in daily operation. Many parts of the work have necessitated delicate planning with the production people to minimize or eliminate the possibility of congestion. In making alterations to the existing building, problems represented by overhead cranes have caused the most concern, and in keeping with good safety practices, much planning has been necessary.

The first section of the building completed was the machine shop con-

Ohio Rolls
SHAPING METAL FOR ALL INDUSTRY
HE-MAN STUFF
There is truth in the saying: "Don't send a boy to do a man's job." That's also good logic and sound economics in steel rolling. To do that man's-size job, to do it well, to keep at it longer without refinishing, is routine with OHIO ROLLS.
Select from any of these eleven types of Ohio Steel and Iron Rolls: Carbon Steel Rolls, Ohioloy Rolls, Ohioloy "K" Rolls, HOLL-O-CAST Rolls, Chilled Iron Rolls, Alloy Chilled Iron Rolls, Denso Iron Rolls, Nickel Grain Rolls, Special Iron Rolls, Nicoloy Rolls, Flintuff Rolls.
THE OHIO STEEL FOUNDRY COMPANY
LIMA, OHIO — Plants at Lima and Springfield, Ohio

tained in the 360 by 80 ft section of the west side of the main stem of the structure. Several large foundations were installed for the mounting of the machinery, and in order to complete all underground piping and electrical work needed, pour a reinforced concrete floor slab, and place the creosoted wood block flooring and cast iron floor plates, a thoroughly efficient construction program was planned and followed. The owner engineered the moving and placing of machinery from the old machine room with a minimum of lost time, and full-scale operation is now in progress.

When the entire job is complete, the Scovill Manufacturing Company will have in operation one of the fastest and most efficient non-ferrous cold-rolling mills in the country. The mill production will be accomplished by rolling ¾ ton and 1 ton brass cakes from a 2½ in. thickness to finished gage thicknesses ranging from .375 to about 0.010 in. The cast cakes entering the new mill are to some degree standardized at 2 ft by 9 ft 8 in., with this size constituting 75 per cent of the production, but two of the other common sizes are 1 ft 4½ in. by 14 ft, and two ft 4½ in. by 7 ft. To make the significance of the brass rolling process more graphic, the reader has but to consider that a 1 ton brass cake as cast, when rolled into a strip 0.010 in. thick and 24 in wide, would measure 2,240 ft if it were allowed to remain one continuous piece. The new development houses three individual mills to be used as processing equipment.

The annealing furnaces have the highest capacities of any in the non-ferrous industry. A single furnace is capable of annealing 33,000 lb of brass per hr footings, consisting of an 80-ft bay added to the westerly side of the old mill, and with a length of approximately 1150 ft. An additional 80-ft bay, 360 ft long, housing the new machine room, motor generator room, and oil storage room, joins the main stem of the structure near the southwest corner. From the northeast corner of the main portion of the new structure two 62-ft bays, running south to the approximate midpoint of the structure, are being erected to replace the portion of the old mill that has been removed to provide the additional section of the new structure which will contain the railroad wells, loading platforms, and storage areas.

LOOK TO THE LEADER FOR THE

PEERLESS CHAMPION

PEERLESS DEEP WELL TURBINE PUMP for Small Diameter WELLS

Squarely meets the need for turbine pump utility, stamina and reliability from 4" wells and larger

Here is the Peerless pump that successfully and completely fills the gap often found between domestic water systems and the larger deep well turbine pumps. The Champion is a powerful water producer from small diameter deep wells; it provides unsurpassed water lifting performance for a host of commercial and industrial uses requiring moderate gallonage and a clean water supply. Read the specifications to the right. If you find that the Peerless Champion turbine pump generally meets the water requirements of your business, write for full details, described and illustrated in a new Peerless engineering Bulletin. Do it today!

PEERLESS CHAMPION SPECIFICATIONS:

CAPACITIES: Up to 5000 gals. per hour

LIFTS: Up to 200 Feet

PRESSURES: Up to 90 lbs.

DRIVES: Available with electric head, right angle geared head for use with horizontal driver or Vee or flat belt drive.

WATER LUBRICATED: OPEN LINE SHAFT CONSTRUCTION

FOR 4 INCH DIAMETER DEEP WELLS AND LARGER

TOP FLIGHT PEERLESS QUALITY CONSTRUCTION THROUGHOUT

WRITE FOR BULLETIN B-200

Contains complete pump description, plus valuable engineering and water pumping data. Fully illustrated.

PEERLESS PUMP DIVISION

FOOD MACHINERY CORPORATION

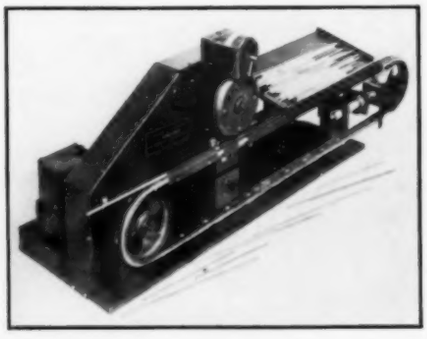
Factories: Los Angeles 31, Calif.; Indianapolis, Ind.

District Offices: New York 5, 37 Wall Street; Chicago 40, 4554 No. Broadway; Atlanta Office: Rutland Building, Decatur, Georgia; Dallas 1, Texas; Fresno, California; Los Angeles 31, California.

MARKING MACHINE FOR RODS, BARS, AND PIPES

▲ Welding rods, solder bars, short-length tubing and similar ferrous and non-ferrous products of ⅛ in. to 2 in. diameter can be printed automatically with a new motor-driven marking machine announced by Pannier Corporation.

The Pannier universal marking



Continental gear drives

for HEAVY-DUTY MILL EQUIPMENT

full range of heavy-duty types and sizes

Continental

FOUNDRY & MACHINE CO.

CHICAGO • PITTSBURGH

Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.

Industry's Headquarters for Rolling Mills and Equipment Iron and Steel Rolls Carbon and Alloy Steel Castings

machine, No. C-1055-A, handles uniform and irregular lengths from 2 in. to 24 in. It prints continuously or intermittently as desired at 72 fpm. It prints in perfect register, thus correctly marks bar recesses.

Powered by a ¼ hp motor, the machine is equipped with a quick-change printing wheel; hopper feed; belt conveyor; automatic, interior-feed ink fountain and adjustments for wear. Printing wheel and conveyor are synchronized. A choice of dovetail rubber wire dies, quick set rubber dies, or interchangeable national rubber type is offered.

The new Pannier "Master Marker" weighs 220 lb; is 44 in long, 14 in. wide and 18 in. high.

PIPE CLEANER FIRM HAS 3-STEP PROGRAM

▲ Federal, state and municipality pollution control bills require elimination of stream pollution by industrial waste. The engineering division of Pittsburgh Pipe Cleaner Company, under the technical direction of one of the foremost industrial waste water authorities, has a complete engineering service to answer all questions relative to this problem.

This service consists of a three-step program to determine the type and size plant necessary to comply with existing regulations and flexible enough for future expansion and requirements. First: A complete survey of the existing sewer systems to determine quantity of waste, quality of waste, a chemical analysis of industrial waste, mapping, location, elevation, and interior condition of present structures. Second: Furnish a complete set of plans, drawings, and specifications for a sewer system and disposal plant that will meet requirements for either discharging industrial waste into a municipal authority or directly into a stream. Third: Cleaning, repairing, replacing, and installing new sewers to fit the specifications and erecting a sewage disposal plant that will meet requirements, turning it over to the user as an operating unit.

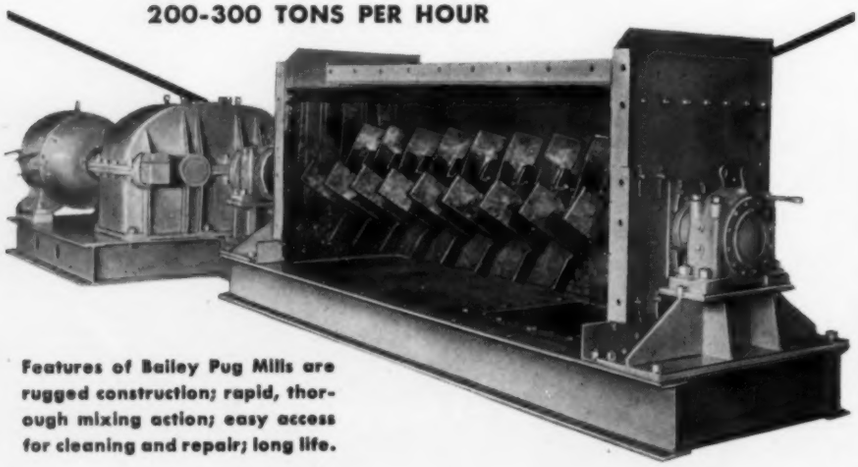
There is only one way to insure adequate waste control, by following a complete step by step engineering survey and scientific analysis of the waste discharged at the present time.

Bailey SINTERING PLANT PUG MILL

Bailey Pug Mills are designed and built to meet the most exacting demands of steel mill service, and are in use throughout the industry. The quality and dependability of these Mills are exemplified by one that operated for more than sixteen years continuously in one of the country's best-known sintering plants. Orders have recently been received from this company for two more Bailey Pug Mills.

We will be glad to send you a bulletin giving complete details.

200-300 TONS PER HOUR



Features of Bailey Pug Mills are rugged construction; rapid, thorough mixing action; easy access for cleaning and repair; long life.

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
PITTSBURGH PENNSYLVANIA

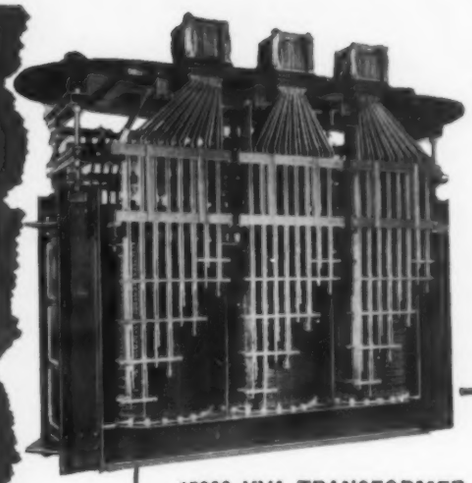
DIAL SCALE MECHANISM CUTS BACKLASH

▲ The Magnetrol, a basically new dial scale mechanism just introduced by Yale and Towne Manufacturing Company, Philadelphia division, achieves for the first time: (1) a straight line relationship between the platform load and pointer movement without specially filed cams, adaptations to prevent backlash or delicate adjustments of the angular relationships between sectors, (2) a reduction of service adjustments from the usual six or seven to only two and (3) full but light engagement between the pointer rack and pinion by means of a permanent magnet. Also noteworthy is the fact that all moving parts are mounted at three fixed centers in a single gray iron casting (the most dimensionally stable of many materials considered). Further, they move on precision ball bearing surfaces to minimize internal friction.

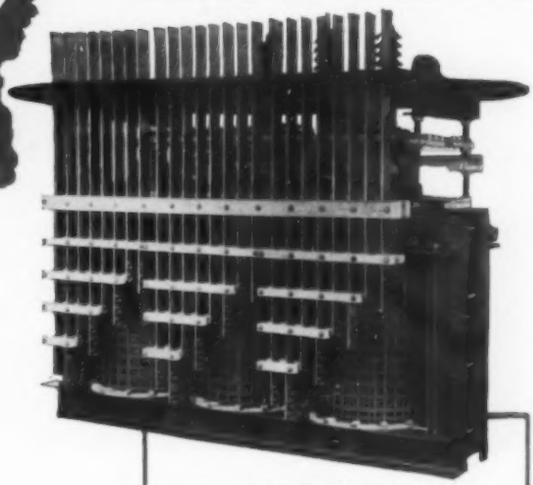
The net result is a new high level of

Over 1 MILLION KVA of Pennsylvania Furnace Transformers *Now in Service!*

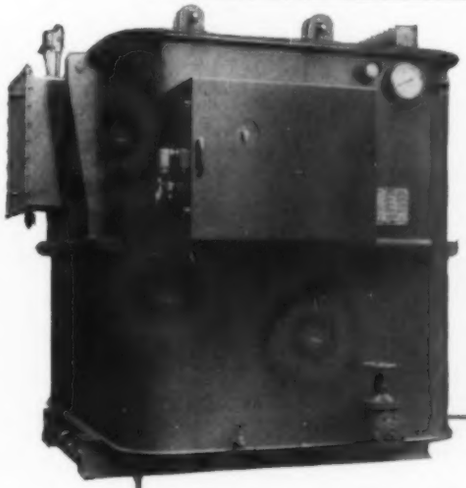
YES, Pennsylvania Furnace Transformers, totaling over 1 Million KVA, are supplying power to hundreds of electric furnaces. The successful operation of these transformers has given Pennsylvania Transformer Company a noted reputation in the Furnace Transformer field. For over 35 years, Pennsylvania Engineers have closely followed the development of Electric Furnaces. They fully understand the problems of Electric Furnaces and their relation to Furnace Transformers.



15000 KVA TRANSFORMER
for operating a 75-Ton Furnace

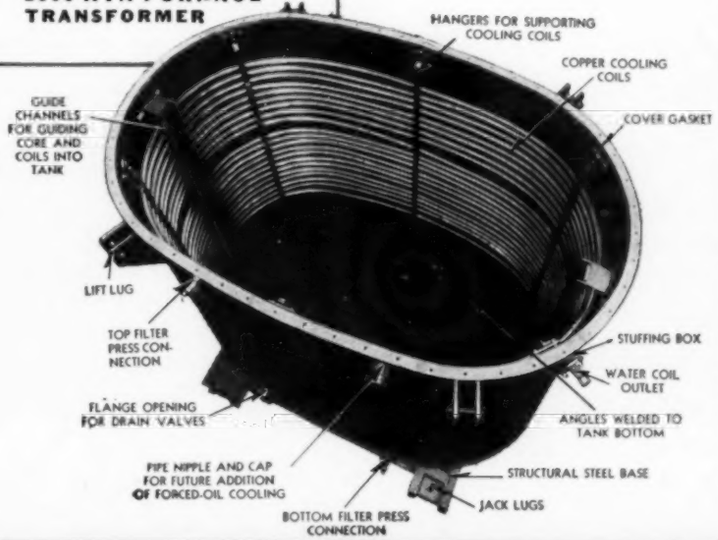


5000 KVA TRANSFORMER
for operating a 15-Ton Furnace



7500 KVA TRANSFORMER
for operating a 30-Ton Furnace

TANK INTERIOR OF 2500 KVA FURNACE TRANSFORMER


HANGERS FOR SUPPORTING COOLING COILS
COPPER COOLING COILS
GUIDE CHANNELS FOR GUIDING CORE AND COILS INTO TANK
COVER GASKET
LIFT LUG
TOP FILTER PRESS CONNECTION
STUFFING BOX
WATER COIL OUTLET
FLANGE OPENING FOR DRAIN VALVES
ANGLES WELDED TO TANK BOTTOM
PIPE NIPPLE AND CAP FOR FUTURE ADDITION OF FORCED-OIL COOLING
STRUCTURAL STEEL BASE
JACK LUGS
BOTTOM FILTER PRESS CONNECTION

Pennsylvania TRANSFORMER COMPANY

Pennsylvania TRANSFORMERS

Furnace Transformer Experts

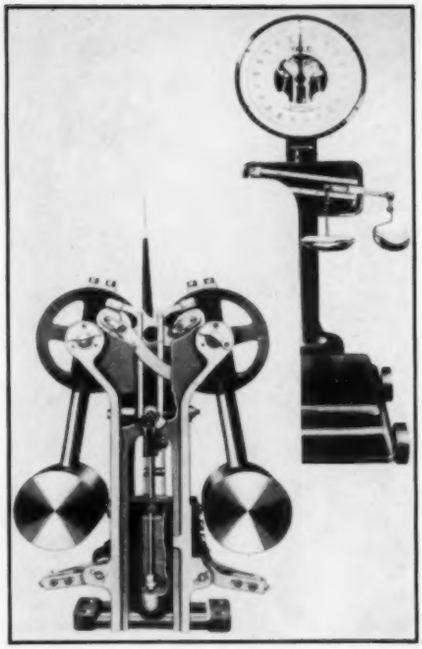
PITTSBURGH 12, PENNSYLVANIA

sustained accuracy, ruggedness and long life.

The capacity of the mechanism under direct loading without any lever system is 25 lb; its application to large industrial loads, up to 50 tons is a matter of lever linkage. Its guaranteed accuracy is one part in 1000, but accuracies of one part in 2000 are readily obtained. The dial head, which contains a 20-in. diameter reading-line dial chart, can be swiveled through 360.

Inherent linearity between load and pointer displacement is achieved because the horizontal component of the displacement of the pendulum weight is directly proportional to both the draft band pull (over a circular drum) and to the vertical component of the displacement of a small roller rigidly affixed to that drum. Because the pendulum-roller system is in duplicate, and the two systems are opposed, the vertical movement of the rollers can be translated through a yoke-plate to a vertical rack. It is this rack which drives the fixed pinion on the pointer shaft.

The ingenious use of an Alnico magnet to keep the rack and pinion in engagement achieves two important functions at the same time: (1) it minimizes friction and (2) keeps teeth in full engagement at all times at exactly sufficient pressure.



The mechanism is amply protected from moisture, water, dust and neglect.

Because there are no cams to file, sectors to orient, or tape lengths to control, there are only two points of adjustment. Ratio adjustment is accomplished by removable plugs within the pendulum weights. The center of gravity of the pendulum weights can thus be adjusted with vernier control. Pointer balancing is achieved in both directions at the pointer hub by means of lateral and vertical screws.

PEACETIME PRODUCTION BEGINS AT PIPE MILL

▲ Peacetime production began August 3 at the No. 2 seamless pipe mill of the Gary plant of the National Tube Company, a United States Steel subsidiary. The mill has been rebuilt and modernized. For a "shakedown" of perhaps 30 days, the mill will be operated on a limited one-turn basis and then will be stepped up gradually to full production.

The mill has been undergoing construction and modernization since the fall of 1947. It will be served by a new huge "doughnut-type" rotary heating furnace and a new 13-unit reheating furnace. "The rebuilt mill is the first long step in National Tube's program to improve and expand its Gary facilities for the manufacture of specialty tubing."

Other new facilities under con-

For Efficient Pickling
USE
Rodine®
The World's Standard Inhibitor...!

Rodine in the pickle bath—either batch or continuous—means improved pickling and lower costs because "Rodine" . . .

CHEMICALS ACP PROCESSES
RUST PROOFING AND PAINT BONDING
Granodine ®
Durdine ®
Rinkite ®
Lithoform ®
Thermal-Granodine ®
RUST REMOVING AND PREVENTING
Deoxidine ®
Pyrolite ®
PICKLING ACID INHIBITORS
Rodine ® ®

SAVES both acid and metal
PROMOTES scale removal
PROLONGS the life of the pickle bath
PREVENTS over-pickling
REDUCES hydrogen embrittlement
PRODUCES cleaner, brighter, smoother surfaces
MINIMIZES acid fumes
IMPROVES working conditions
BOOSTS pickling production

"Rodine" more than pays for itself in savings of acid and metal.

Pioneering Research and Development Since 1914
AMERICAN CHEMICAL PAINT COMPANY
AMBLER, PA.
Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

struction or definitely planned at Gary include another seamless tube mill of a different and even more advanced type. The No. 2 seamless mill will be able to turn out tubes from three to nine inches in outside diameter and up to 45 ft long.

The mill's new rotary heating furnace is described by the plant engineer, W. J. Fletcher, as the only furnace of its kind in the country having as many as five separate heating zones. The great circular kiln has an outside diameter of 61 ft and an inside radius of 19 ft. Temperatures in each heating zone can be controlled independently of the others.

The new facilities are specially adapted to the production of specialty (quality) tubing, which is made in a great variety of sizes of precise dimensions and much of which is in varying grades of alloy. The Gary plant will specialize in alloy, stainless, and carbon tubing (mechanical and pressure), such as is used extensively in dairy plants, chemical plants, all kinds of aircraft, ball and roller bearing races, industrial conveyor rolls, still tubes and many other ways.

PHYSICIST TRACES METAL IMPURITIES

▲ Vaporizing metal samples in a small filament-type furnace has enabled Westinghouse physicist, William M. Hickam, to trace metal impurities by means of a mass-spectrometer. Using two milligram samples, the new method will detect as little as one part of the impurity per million. The equipment was devised for a special research project and is not commercially available.

The mass-spectrometer has been used for some time in the analysis of gases, but this is thought to be its first successful application to metals. Its use will permit completing an analytical job that would take days by chemical means in a few minutes.

The mass-spectometer consists essentially on an ionization chamber and a curved section with narrow slots at each end. Ions of the vapor being analyzed are separated electromagnetically so that only those having certain atomic weights pass around the curve and through the exit slot. These are deposited on a plate just beyond the slot. Their quantity is determined by measuring the charge on the plate.

85-TON BILLET FURNACE REPLACES 20 YEAR OLD JOB

▲ An 85-ton per hour billet heating furnace which will replace a 40-ton furnace in use since 1929 will be designed and built for Timken Roller Bearing Company, Canton, Ohio, by Rust Furnace Company.

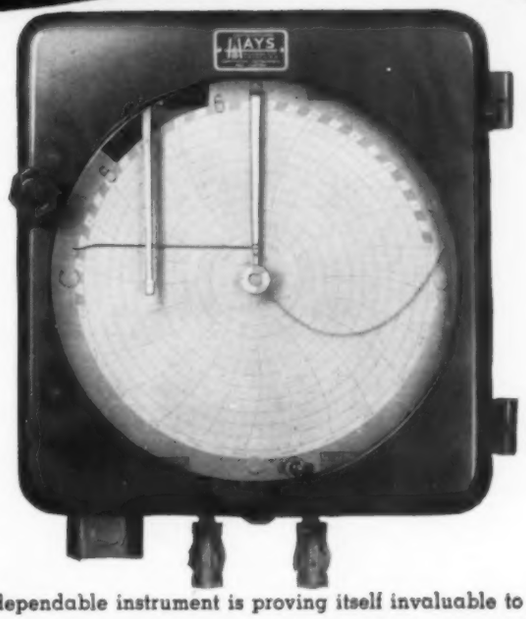
The furnace being replaced is one of the first two Rust patented triple-fired, zone controlled furnaces put in service. Both original furnaces have been serving the Timken plant continuously for 19 years.

The new furnace will operate on the same basic principle as the original heaters, with the addition of modern developments. It calls for combination burners providing firing by either natural gas or fuel oil. It will be equipped with recuperator, and combustion and temperature control.

Effective length of the new furnace

A Practical Means TO CLOSER QUALITY CONTROL

The HAYS "OT" Pressure Recorder



THIS dependable instrument is proving itself invaluable to the steel industry . . for maintaining proper atmospheres in soaking units, annealing furnaces, open hearth furnaces, slab mills, and any place where an accurate record of draft, pressure or differentials is required.

You get an errorless record of two draft values, two pressure values, two differential values, or any combination of two of those values.

A good many new and modernized open hearth installations are equipped with Hays Series "OT" Pressure Recorders . . . as a simple, dependable, practical means to closer quality control.

Step 1 toward getting the benefits of this modern quality control is to get the facts about it. Bulletin 43-586 tells them . . . better send for it.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA U.S.A.

come recent orders for Morgan Rolling Mills

Rolling mills are not bought over the counter. Orders are placed only after months of engineering and investigation. All officials must be thoroughly satisfied that the plant layout is right, the mechanical equipment is right and prospects are good for profitable operation.

Confidence in the builder is of prime importance in considering a new rolling mill. We are deeply conscious of the obligations that go with the confidence shown in the Morgan organization.

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

Rolling Mills - Morgoil Bearings - Wire Mills - Regenerative Furnace Controls - Ejectors

English Representative—International Construction Co., 56 Kingsway, London, W.C. 2, England

RM-19

MORGAN WORCESTER

will be 85 ft and the inside width will be 20 ft. Design is now underway and construction will begin late in 1948.

SMOKE RECORDER FOR SMOKE DENSITY

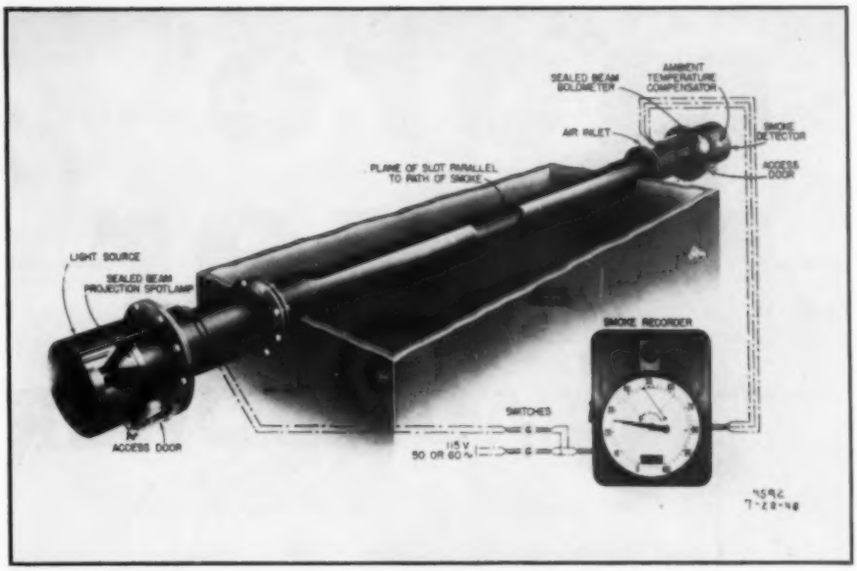
▲ Bailey Meter Company has developed a new electronically-operated smoke density recorder which accurately measures and records the density of smoke or dust in flues or ducts. The valuable records thus obtained prove compliance with smoke ordinances and under certain conditions give the first warning of faulty combustion conditions in furnaces. The instrument consists of a standard Bailey electronic recorder, a bolometer type smoke detector and a sealed beam light source.

The bolometer type smoke detector and the sealed beam light source are used as the primary element. They are installed on opposite sides of the smoke passage so that the beam from the light source is directed at the tungsten filament of the bolometer. The bolometer principle as used in this recorder is the same as used by astronomers for measuring the radiation from stars. The amount of radiation reaching the filament is dependent upon the density of the smoke or dust; and the temperature of the filament is dependent upon the amount of radiation reaching it. The filament temperature is measured by the electronic recorder in terms of smoke density.

To insure proper alinement of the bolometer and light source they are mounted on opposite ends of a 4 in. pipe extending across the entire width of the smoke passage. This pipe is slotted to insure the free passage of smoke into the radiated beam from the light source.

A temperature compensating circuit eliminates errors due to high ambient temperatures, and is unaffected by normal voltage variations. The bolometer is of "sealed beam" construction (similar to the common automobile head lamp) to resist the usual corrosive vapors found in flues.

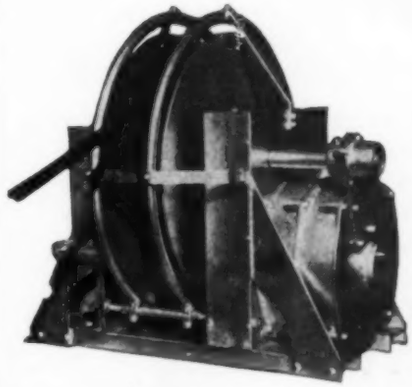
The voltage drop across the bolometer filament is balanced against the voltage drop across a motor driven slidewire unit in the recorder casing. When the temperature of the filament changes the potentiometer becomes unbalanced and the slidewire is automatically repositioned to restore the balance. The recording pen is directly connected to the slidewire unit and is correspondingly repositioned.



The bolometer type smoke detector and the sealed beam light source are used as the primary element.

Two Bailey smoke detectors may be connected to a two-pen recorder to record the smoke density in two different flues. On the other hand a record of smoke density may share the same chart with one of temperature, per cent oxygen, or some other related factor. Each measuring circuit may be equipped with switches to

A NEW LINE OF
EXTRA HEAVY DUTY
GLEASON CABLE REELS



SM SERIES

Spring Driven Geared Reel
For Electric Cables
125 Amps — 600 Volts
Continuous Contact
All Ball Bearings
Two-way Payout
Non-Revolving Springs
Fabricated Steel
Watertight
Replaceable Spring Motors
Adjustable Tension
8 Standard Sizes

These reels were developed to meet the unusually severe operating conditions found throughout the steel industry and are of exceedingly rugged construction.

The spring motors are interchangeable and removable so they may be replaced without handling loose springs. Replacement springs are supplied by the factory already installed in the housings and the replaced housings are returnable for credit.

The springs are wound on extra large hubs to minimize flexing at that point.

Adjustment of the spring torque is accomplished by means of a crank handle which is removable. A lock is provided to hold the drum in position during spring adjustment.

Improved current collector and brush rigging, with extra wide spacing, minimizes the possibility of electrical troubles.

J. L. GLEASON & CO., Inc., 209 Bent St., Cambridge, Mass.

more power WITH READY-POWER

Ready - Power - equipped Elwell Parker Up Ender handling heavy steel coils.

FOR ELECTRIC TRUCK OPERATION AT ITS BEST!

Ready-Power-equipped electric trucks provide more power for heavy loads, more continuous hours of service and more materials handled in any given period. Dependable electric power is generated right on the truck chassis by an engine-driven, direct-current generator. Get the most out of your electric trucks. Convert them to Ready-Power. Specify Ready-Power on your new trucks. Write for descriptive literature.

Ready - Power - equipped Automatic Ram Trucks handling steel coils.

THE READY-POWER CO.

3836 Grand River Ave., Detroit 8, Michigan

actuate signals or alarms when the smoke density reaches a predetermined maximum value. They may also be equipped with control to automatically turn on over-fire air jets.

PITTSBURGH FIRM TO HANDLE SHEET LIFTERS

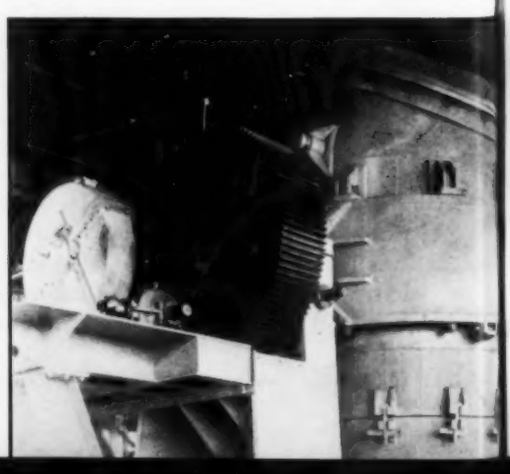
W. G. Kerr Company was appointed as Pittsburgh representative for Cullen-Friestedt Company, manufacturers of welding positioners, sheet lifters, and burrow cranes. They also handle Foote Brothers Gear and Machine Corporation, Reeves Pulley Company, Inc., Thomas Flexible Coupling Company and Smith Engineering Works. The Kerr Company is located in the Oliver Building, Pittsburgh, Pennsylvania.

LORAIN BESSEMER SOON READY FOR OPERATION

▲ Soon to go to National Tube Company's plant at Lorain, Ohio, is a 30-ton bessemer converter. The new bessemer plant is one of the important projects in United States Steel's expansion program. The converter is of welded plate construction with supporting stands, trunnion ring, shell and bottoms. A minimum of castings is used and in the case of a trunnion ring, the trunnions are castings which are welded to the plate ring.

The drive gearing has cut teeth, the trunnion gearing having cast herringbone teeth previously. Anti-friction bearings are used throughout with

This Pennsylvania Engineering converter is nearly ready for operation at Lorain, Ohio.



the exception of the trunnion ring bearings which are bronze bushed. Grillage beams are supplied for connecting the two supporting stands to better maintain the alignment of the gearing. The converter was built by the Pennsylvania Engineering Corporation.

TRUMBULL ELECTRIC SETS NEW SALES RECORD

▲ Trumbull Electric Manufacturing Company has sold through its distributors over one-half million new Type D front- operated switches in the past eleven months. This more than equals the total number of side-operated Type D switches sold in the last ten years.

COLORADO FUEL & IRON TO REDUCE SHORTAGES

▲ Colorado Fuel and Iron Corporation, Pueblo, Colorado, has promised assistance in relieving the critical shortage of pig iron among two hundred foundries in the New England area, resulting from the closing of Mystic Iron Works' blast furnace for relining.

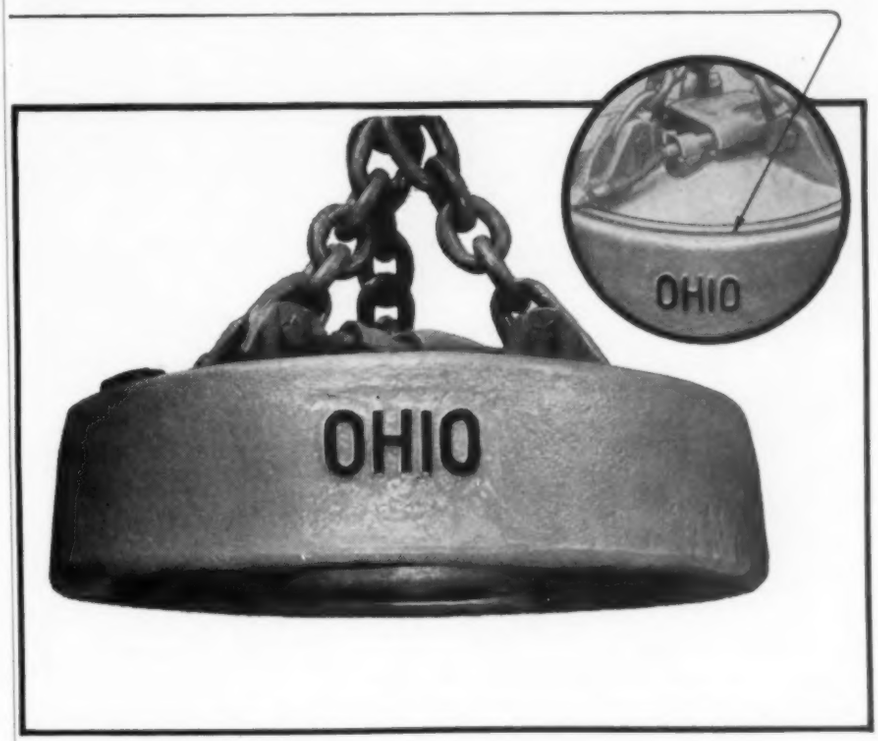
The relief pig iron will be shipped from the Wickwire-Spencer Steel division's plant, where a new stack was put into blast about August 16.

DRAVO FIRM MOVES TO NEW BUILDING

▲ Dravo Corporation recently announced it had completed transfer of its city offices from the Dravo Building at 300 Penn Avenue to the former Pitt Bank Building, Fifth and Liberty Avenues, purchased by the corporation last year. The 12-story building, one of Pittsburgh's first "skyscrapers," has been renamed Dravo Building.

Movement of Dravo's offices to the new location is another step toward the realization of the Point Park Development because the old eight-story former Dravo Building was purchased by the state on February 27, 1947 and will be razed sometime in the future. Built in 1913, it had served

It pays to know where the weld should be!



A LIFTING MAGNET, when properly designed, is a long term investment. You can look into a magnet's future *simply by looking into its construction.*

For instance, look at a welded lifting magnet. Where is the weld? Obviously it should be ON TOP OF THE MAGNET where it cannot be damaged by hard knocks.

Only new Ohio PROTECTO-WELD Magnets offer you this advantage. Outer ring and top plate are welded together ON TOP OF MAGNET. Thus, the weld is never dented in, retains its shape permanently. You can turn down the weld for magnet disassembly without cutting away outer ring... without destroying outer pole.

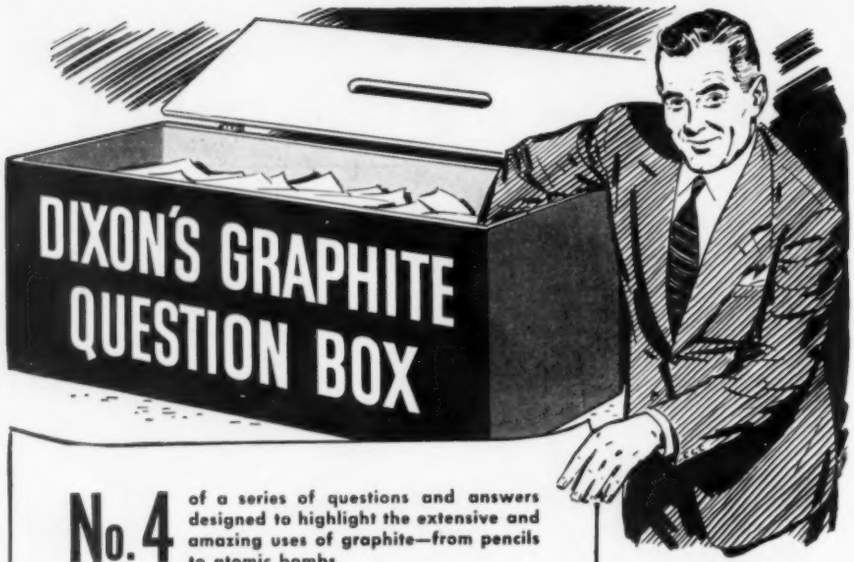
It pays to know where the weld should be! And it pays to *standardize* on Ohio lifting magnets. They operate cooler... lift bigger loads all day long ...cost less to maintain... last years longer. Sizes? 39, 46, 55 and 65 inches diameter. For details, write today to Ohio—*leader in magnetic materials handling.*

Ohio is also a leading name in the small motor industry

Ohio MAGNETS

THE OHIO ELECTRIC MFG. CO.

5907 MAURICE AVE. • CLEVELAND 4, OHIO



No. 4 of a series of questions and answers designed to highlight the extensive and amazing uses of graphite—from pencils to atomic bombs.

GRAPHITE IN THE ROLLING MILL

QUES. Has graphite a long standing reputation for effectively lubricating cylinder walls of steam and internal combustion engines, including Diesels?

ANS. Definitely yes. One of its earliest applications, graphite is widely used for swabbing the walls while making repairs.

QUES. Is graphite effective in hydraulic pumps, and if so, where?

ANS. It has been an old standby for generations, on pump pistons and piston rods.

QUES. What's behind the age-long practice of coating or impregnating mechanical packings, gaskets and pipe joints, bolts and assemblies with graphite?

ANS. Graphite maintains long lasting lubrication and leakproofness in packings; prevents destructive, corrosive deterioration of gaskets and pipe joint fittings, assuring easy setting up and disassembling even years later.

QUES. Is graphite serviceable as a pigment in protective coatings for equipment subject to excessive heat?

ANS. It is unequalled, and in some formulations also provides an attractive, lustrous, silvery polish, when rubbed.

QUES. Do graphites and graphited lubricants cost more than non-graphited lubricants?

ANS. They cost somewhat more by the pound or gallon but are definitely cheaper in the long run, when measured in terms of ultimate savings in reducing wear on bearings, gears, chains, etc., and time and expense of making more frequent lubricant replacements.

A few of thousands of widely used products containing Dixon's Graphites. If starred they are Dixon's products, many of them sold by supply houses everywhere.

★Waterproof Grease

★Auto-Marine Grease

★Slipstik, Greastik, G-711 Stick

Now may we receive *your questions* on how graphite can help *you?*

DIXON'S GRAPHITES

Products of
JOSEPH DIXON CRUCIBLE COMPANY
Jersey City 3, N. J. Div. 18-Q-9

LOOK FOR No. 5
in this series. We will gladly send you reprints of any you may miss.

as Dravo's city headquarters since 1922.

Occupancy of its new quarters was something of a homecoming for Dravo Corporation because between 1913 and 1919 the corporation had its city offices in that building, then known as Diamond Bank Building.

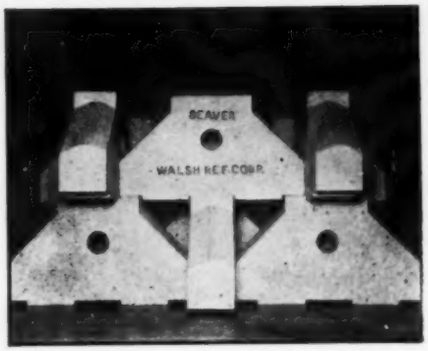
PORTABLE BRAKE FOR SHEET BENDING

▲ New "WEBCO" portable sheet metal brakes, featuring detachable open end bars and adjustable finger assemblies, are now being manufactured by Webb Machine and Tool Company. The new brakes, with improved hinges and redesigned folding arms, bend sheets (steel, aluminum, copper, or lead) up to 18 gage, depending on brake model and folding arm used. Clamping bar operates with flip of finger tip, adjusts automatically for all gages. On model W-48, open end bar has 37 in. working width face; 12¼ in. width each end of bar. On model W-30, open end bar has 27 in. working width, face; 8¼ in. width each end of bar. Sliding folding fingers are available in seven sizes. Standard bars have working widths of 31 in. or 49 in., depending on model. Folding bars can be removed for bends impossible to make on fixed bars. Stands are detachable, permitting entire unit to be carried in back of car or pick-up truck.

CHECKER BRICK INCREASES HEAT SURFACES

The Seaver checker brick permits the design of an improved basket weave checker system which gives added features to the established proven system that has stood the test of time. Designed primarily to increase the heating surface in hot blast stoves, this new and radically different checker brick has been found to be equally applicable to installation in open hearths, soaking pits, glass furnaces, water gas sets and similar applications where increased surfaces are desirable to provide greater heating areas and increased productive capacity.

The Seaver cross-vent checker brick is a simple rectangular brick with the upper corners bevelled off



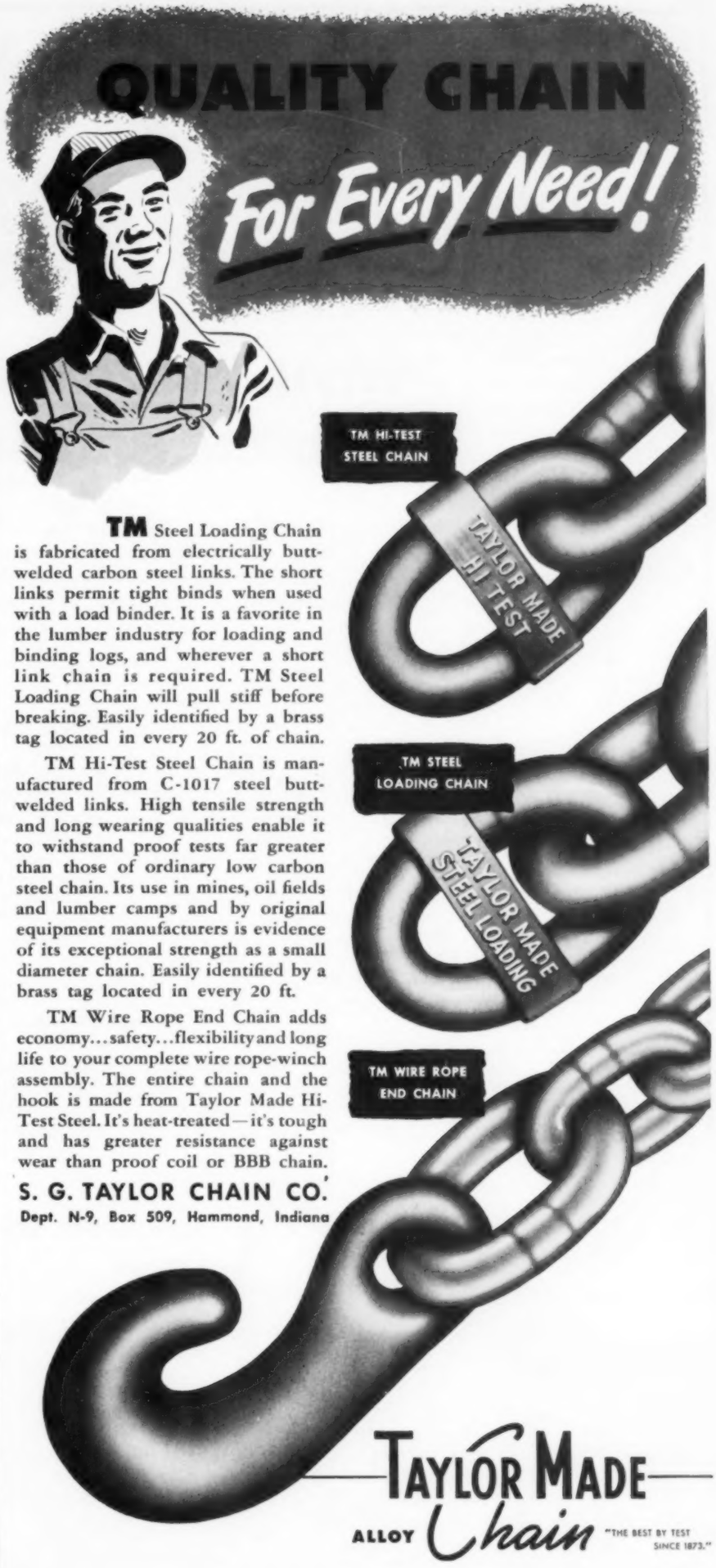
and a hole through the middle which gives additional heating surface and equalized heating and pressure over the entire area and lancing openings, if required. Made in stable shapes with the center of gravity below the middle, it is laid up in standard basket weave pattern, but due to a unique and simple cut-away section, each brick is securely locked top and bottom with other brick and cannot move in any direction.

This new brick increases heating surface 30 per cent over present installations in stoves with plain basket weave checkers, has 90 per cent of the volume exposed, and gives equalized heat and air over the complete checker area with turbulence and high heat exchange. It cannot twist or turn and may be used with or without tubular inserts.

CARNEGIE LICENSES GREER STEEL FIRM

▲ Carnegie-Illinois Steel Corporation, United States Steel Corporation subsidiary, has announced that the Greer Steel Company, Dover, Ohio, has become the eighth steel company to be licensed to manufacture "Cor-Ten," well-known corrosion-resisting high-strength, low-alloy steel, developed by Carnegie-Illinois.

Prior to 1944, "Cor-Ten" was produced solely by subsidiaries of the United States Steel Corporation. Since then, an imposing group of producers, including Lukens Steel Company, Republic Steel Corporation, Crucible Steel Company of America, Colvilles Limited (Glasgow, Scotland), United Steel Company Limited (Sheffield, England), Inland Steel Company, and Sharon Steel Corporation, have been licensed by Carnegie-Illinois to manufacture "Cor-Ten."



TM Steel Loading Chain is fabricated from electrically butt-welded carbon steel links. The short links permit tight binds when used with a load binder. It is a favorite in the lumber industry for loading and binding logs, and wherever a short link chain is required. TM Steel Loading Chain will pull stiff before breaking. Easily identified by a brass tag located in every 20 ft. of chain.

TM Hi-Test Steel Chain is manufactured from C-1017 steel butt-welded links. High tensile strength and long wearing qualities enable it to withstand proof tests far greater than those of ordinary low carbon steel chain. Its use in mines, oil fields and lumber camps and by original equipment manufacturers is evidence of its exceptional strength as a small diameter chain. Easily identified by a brass tag located in every 20 ft.

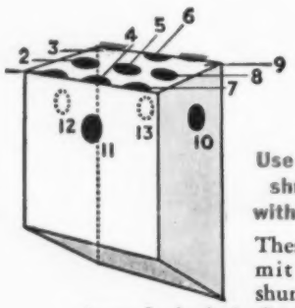
TM Wire Rope End Chain adds economy...safety...flexibility and long life to your complete wire rope-winch assembly. The entire chain and the hook is made from Taylor Made Hi-Test Steel. It's heat-treated—it's tough and has greater resistance against wear than proof coil or BBB chain.

S. G. TAYLOR CHAIN CO.
Dept. N-9, Box 509, Hammond, Indiana

TAYLOR MADE ALLOY Chain "THE BEST BY TEST SINCE 1873."

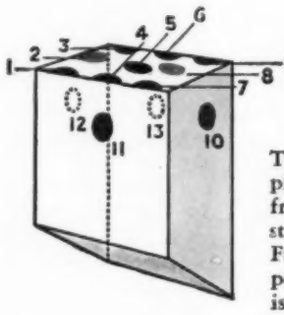
MORE WAYS TO reduce inventory WITH "NATIONAL" CARBON BRUSHES . . .

You can simplify your brush inventory by stocking brushes with standardized lengths, grades, shunt types, and terminals. Here are more ways to simplify your brush specifications . . . without affecting brush operation:



Use No. 3 or No. 9 shunt locations with R connections

These locations permit bringing the shunt out of a slot instead of a hole. Less chance of fouling pressure fingers. Further simplification is possible if the No. 9 location is always made first choice.



Use No. 2 or No. 8 shunt locations with Q connections

These locations are the simplest and most economical from the standpoint of installation and maintenance. Further simplification is possible if the No. 8 location is always made first choice.

The term "National" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

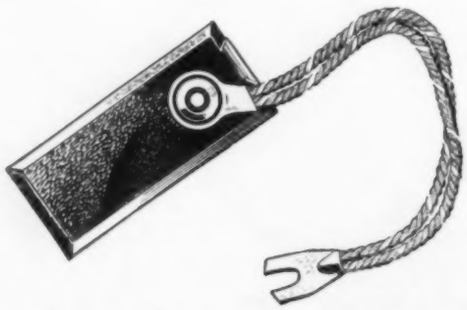
30 East 42nd Street, New York 17, N. Y.

Division Sales Offices:

Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

Eliminate "A" clips where possible

On stronger grade brushes, the "A" clip may be eliminated without adversely affecting brush life or performance.



HOW BRUSH STANDARDIZATION PAYS

1. Permits buying in economical quantities
2. Fewer small orders—with savings in bookkeeping, billing, and accounting
3. Less money and space tied up in brush stocks
4. Less time needed to handle stock

Write for free copy of 24-page booklet titled "Standardization of Carbon, Graphite and Metal-Graphite Brushes for Motors and Generators." Address your nearest division office of National Carbon Company, Inc., Dept. IS

Personnel News . . . .

Freeman H. Dyke, former assistant general manager of the steel works of the Wheeling Steel Corporation at Steubenville, Ohio, has resigned to become manager of operations, Compania, de Acero del Pacifico, Concepcion, Chile. Mr. Dyke thus becomes the operational head of a new steel plant now being constructed in Chile which will have a capacity of 200,000 tons of finished steel per year.

Mr. Dyke graduated from Phillips Andover Academy and from the Massachusetts Institute of Technology and served with the infantry as a lieutenant in World War I. He began work in the steel industry in 1920 at the Portsmouth, Ohio plant of the Wheeling Steel Corporation and has been with them continuously ever since, except for three years with the Jones and Laughlin Steel Corporation. He became superintendent of the hot strip, slab and bar mills in 1934 and was made assistant general manager in 1943. Mr. Dyke has been extremely active in the Association of Iron and Steel Engineers and served as president of the Association in 1946. At the present time, he is on the Board of Directors of the Association.

C. R. Fischer was named as sales representative for George P. Reintjes Company for the eastern half of Pennsylvania and New Jersey. Mr. Fischer has had a wide experience with the Fenno-Fischer Company, as manufacturers' representatives in this area. He will be located at 632 South 48th Street, Philadelphia, Pennsylvania.

Dr. D. P. Morgan, who recently joined Mathieson Chemical Corporation as administrator of research and development, has been appointed vice president in charge of the development department. Before coming to Mathieson, Dr. Morgan was in charge of chemical market research and development at W. R. Grace and Company. During the last several years of World War II, he served as Director of the Chemicals Bureau of the War Production Board. Prior to that he was associated with Scudder, Stevens and Clark as a chemical consultant. Dr. Morgan is a graduate of Harvard University and received his Ph.D. in chemistry from Columbia University.

A. C. Monteith, 46-year-old engineering executive of the Westinghouse Electric Corporation, has been elected vice president in charge of engineering and research. Mr. Monteith was born in Brucefield, Ontario, in 1902, and is now a naturalized U. S. citizen. He was graduated from North Bay preparatory school, and then entered Queens University at Kingston, Ontario, graduating with the bachelor of science degree in electrical engineering in 1923. Mr. Monteith's 25-year electrical engineering career began at the Westinghouse East Pittsburgh works. He joined the company in 1923 as a graduate student engineer in the training course, and was assigned to the central station engineering department in 1924. He became manager of that department in 1938 and in 1941 was named manager of the industry engineering department. In 1945, he took over the dual position of manager of headquarters engineering departments and director of education.

John M. Lutz, Sr. was named vice president in charge of sales of the L. R. Kerns Company of Chicago. Mr. Lutz has been a director and officer of the L. R. Kerns Company for the past thirteen years.

Mr. Lutz has been associated with both the steel and oil industry since 1913. After leaving Cornell University in 1913, he became connected with the Texas Company for a short period, after which he spent ten years in the engineering department of the Tennessee Coal, Iron and Railroad Company in Birmingham, Alabama. In later years he has served in varying capacities with the Standard Oil Company of the New Jersey group, United Engineering and Foundry Company, and during the past nine years he has been associated in engineering and sales with the Continental Foundry and Machine Company.

Russell Kreinberg was elected president of Electric Service Manufacturing Company, succeeding **H. G. Lewis**, deceased. Mr. Kreinberg was previously executive vice president. His long association with the firm has seen him rise through the ranks of the sales department to become head of the New York office in 1927,

FREEMAN H. DYKE

A. C. MONTEITH

JOHN M. LUTZ, SR.

RUSSELL KREINBERG

member of the board of directors in 1937, and executive vice president in 1946.

Ira W. Schmidt, formerly vice president in charge of Electric Service Manufacturing Company's western division, has been elected vice president and sales director. He also has seen long service with the firm, having started in 1911 and advanced through various managerial capacities to a seat on the board of directors. Additional changes include **E. A. Leinroth** from vice president and sales manager to vice president and treasurer; **H. J. Graham** to vice president in charge of manufacturing; **D. B. Reeves** to assistant treasurer, and **J. R. McFarlin** was re-elected vice president and secretary. Three new members have been admitted to the board of directors.

John E. N. Hume, commercial vice president of the General Electric Company, has retired after 41 years' service. Born near Alexandria, Virginia, Mr. Hume was graduated from the University of Virginia in 1906 with a bachelor of science degree in electrical engineering. The following year he joined General Electric on the test course at Schenectady, and after completing the course entered the switchboard engineering department. In 1911 he was transferred to the Baltimore office as a salesman, and returned to Schenectady the following year in the industrial department. Later he became manager of sales of the mining and steel section of that department. In 1928 Mr. Hume became manager of the motor division and in the following year assistant manager of the entire industrial department. After being named manager of the department in 1935, he was elected a commercial vice president of the company in 1938.

A. P. Heiner was named assistant to the vice president in charge of public relations for the iron and steel division of Kaiser Company, Incorporated. Mr. Heiner has been with Kaiser Company, Incorporated for the past six years as general traffic manager and will retain general supervision of that department in addition to the new public relations duties.

Sheldon Thomas, former assistant to **Robert W. Ward,** vice president in charge of production of American Car and Foundry Company, has been appointed assistant district manager of the company's Chicago, Illinois plant.

Robert J. Powell was named refractory sales engineer for Babcock and Wilcox Company in Alabama, Tennessee, western Georgia and Florida, effective September 1. Mr. Powell will make his headquarters at 1604 Candler Building, Atlanta, Georgia.

H. L. Smalley was appointed assistant to the vice president of Harbison-Walker Refractories Company, with general supervision over the company's Chicago, Detroit and Indianapolis districts.

Myron S. Curtis, manager of sales promotion department, was placed in charge of a new industrial development division of Youngstown Sheet and Tube Company, Youngstown, Ohio. It will be the function of this division to contact consumers of steel, particularly customers of Youngstown, who desire to investigate the possibilities of locating in the Youngstown area.

J. E. Crotty was appointed as sales engineer of wire drawing equipment for Aetna-Standard Engineering Company, Youngstown, Ohio. Mr. Crotty attended Ohio University and was afterward employed by the

J. E. CROTTY

W. S. Tyler Company, Cleveland, Ohio, for three years in the screening machine engineering department. He was with the Trauwood Engineering Company from 1939 to 1946 designing and engineering wire heat treating and processing equipment. Between 1946 and 1948 he was manager of the wire department for Manganese Steel Forge Company, Philadelphia, Pennsylvania.

F. Clark Schoen, formerly plant engineer, Midvale Company, Philadelphia, is now maintenance engineer, Alan Wood Steel Company, Conshohocken, Pennsylvania.

Whitley B. Moore was elected vice president in charge of sales, succeeding **L. M. Klinedinst,** who after 43 years of service retired under Timken Roller Bearing Company's annuity plan in effect for the past several years. Mr. Moore after graduating in 1919 from the University of Michigan's Engineering School served in the Navy. When he came with the company he was first assigned to factory equipment engineering and later was transferred to the Pacific Coast in charge of sales and engineering for all territory west of the Rocky Mountains. Later he was moved to Canton as assistant general manager of the industrial bearings division and later became manager of that division. During World War II, Mr. Moore had charge of steel sales division and about three years ago was appointed director of all sales.

Mr. Klinedinst joined the company in 1905. He was a lock maker at the York Safe and Lock Company in York, Pennsylvania. His first position was assistant chief inspector He rose progressively through the shop to the positions of chief inspector, assistant superintendent having charge of shipping, stores, stock follow-up, etc., later was assigned to assistant production manager and later production manager, and in January, 1916 was made sales manager of the division manufacturing axles and boxes for horse drawn vehicles. It was largely through his guidance that the company branched from the wagon and automotive field into the farm

implement and industrial business, which in the last 25 years has been chiefly responsible for the growth and expansion of the Timken bearing business.

In 1918 he was made assistant general sales and advertising manager, position he held until 1924 when he was made general manager of the industrial division. He was elected vice president in April, 1930 and a director in October, 1934. Mr. Klinedinst is today recognized as one of the bearing pioneers of America for his work in promoting the use of anti-friction bearings in all types of automotive and industrial equipment.

Mr. Klinedinst will remain a director of the company and further serve as sales consultant.

Anthony Siragusa was appointed as assistant to vice president, purchases, United States Steel Corporation of Delaware. Mr. Siragusa formerly was supervising buyer, purchasing division of United States Steel Corporation of Delaware. Mr. Siragusa will make his headquarters in Pittsburgh, Pennsylvania, and will continue to be in charge of the purchasing matters which he formerly handled in New York City. The New York purchasing office was consolidated with the United States Steel Corporation of Delaware purchasing department at 436 Seventh Avenue, Pittsburgh, effective September 1, 1948.

Marvin Leeper, 46, has been appointed plant engineer at the Gary, Indiana, plant of American Bridge Company. Mr. Leeper is succeeding C. J. Kennedy who died

MARVIN LEEPER

recently following a brief illness. Mr. Leeper joined the bridge-making subsidiary of United States Steel in 1926, shortly after being graduated from the University of Arkansas. His first job was as a draftsman. In 1941, Mr. Leeper was made a supervisor and a year later became the drawing room engineer, the job which he held at the time of his present appointment.

Harold S. Dunn was made Pittsburgh district sales manager for Harbison-Walker Refractories Company. Mr. Dunn was formerly sales manager of the Portsmouth, Ohio, district.

J. P. Bankson has been named assistant to the vice president of Harbison-Walker Refractories Company. Graduated from Yale College in 1922, Mr. Bankson was associated with General Refractories Company for eight years. In 1930 he joined the Cleveland office of

KNIFE-BLADE
250 VOLTS
600 VOLTS
70 to 600 AMPS.

FERRULE
250 VOLTS
600 VOLTS
3 to 60 AMPS.

To Handle In Renewing Link

WARE HI-LAG FUSE Construction establishes a top standard for rugged simplicity. There are only *3 PARTS* to handle to replace blown link:—the Fibre Case—the Knife-Blade Assembly—the Closure Ring. Only 1 wrench needed to loosen nuts and slip out blown link. Assembly can be inserted either end in Case.

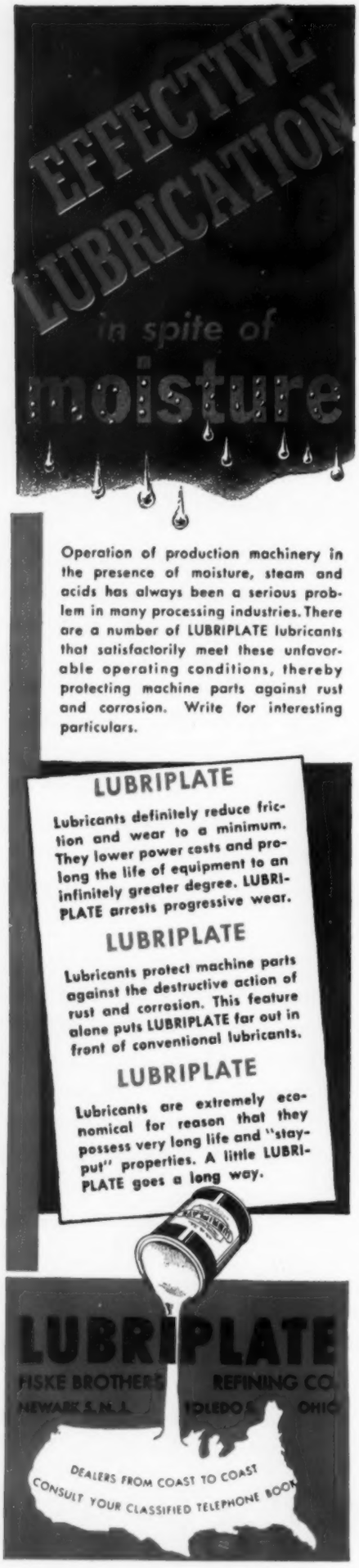
Other exclusive WARE HI-LAG features which add to their cool operation—low resistance—dependability and long life service are: Large Double Contact Areas between Link and Blades—Steel Arched Lock Washers—Heavy Double Fibre Bridge—Gas Vents—Lateral Expansion Links.

We manufacture all of our own parts and are making prompt deliveries.

APPROVED BY UNDERWRITERS LABORATORIES

Write for Free Booklet No. 4460 giving all features, sizes and details.

WARE FUSE CORPORATION
4450 W. LAKE ST. CHICAGO 24, ILL.


EFFECTIVE LUBRICATION
in spite of
moisture
Operation of production machinery in the presence of moisture, steam and acids has always been a serious problem in many processing industries. There are a number of LUBRIPLATE lubricants that satisfactorily meet these unfavorable operating conditions, thereby protecting machine parts against rust and corrosion. Write for interesting particulars.
LUBRIPLATE
Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.
LUBRIPLATE
Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.
LUBRIPLATE
Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.
LUBRIPLATE
FISKE BROTHERS REFINING CO.
NEWARK 5, N. J. TOLEDO 5, OHIO
DEALERS FROM COAST TO COAST
CONSULT YOUR CLASSIFIED TELEPHONE BOOK

Harbison-Walker as a salesman, and in 1935 he was transferred to the Pittsburgh headquarters as district sales manager. He had served in that capacity until his recent appointment.

Marvin W. Smith was elected executive vice president of Baldwin Locomotive Works. Mr. Smith came to Baldwin from the Westinghouse Electric Corporation

MARVIN W. SMITH

where he was vice president in charge of engineering and research, and an authority on power plant design and development.

Lewis W. Metzger, vice president of Baldwin Locomotive Works, has been made executive assistant to the executive vice president. Announcement also was made of the appointments of **James R. Weaver** as manager of manufacturing, Eddystone division, and **John S. Newton** as manager of engineering, Eddystone division.

G. L. Harman, Jr. has been appointed manager of the company's Milwaukee branch office. Mr. Harman is a mechanical engineering graduate of Rensselear Polytechnic Institute and has been associated with Bailey Meter Company since 1937.

Robert P. Bremner has been appointed mining engineer for Youngstown Sheet and Tube Company. Mr. Bremner came to Youngstown several months ago from the Lake Superior iron ore region where he had spent 11 years with Pickands, Mather and Company. During that time he spent six years as district geologist and mining engineer on the Gogebic range and as mining engineer at the Newport Mine at Ironwood, Michigan; one year as assistant mining captain at the Cary Mine, Hurley, Wisconsin, and three years as mining captain at the Newport mine. He is a native of Mabel, Oregon, attended grade and high school in Milwaukee and received a bachelor of science degree in mining and geology from the University of Wisconsin.

R. N. Bryan was appointed chief engineer of Wisconsin Steel works International Harvester Company, to fill position occasioned by the retirement of **J. H. Dillon**. Mr. Bryan started his engineering career with the Baldwin Locomotive Works in Philadelphia, Pennsylvania and later became assistant chief engineer of the H. K. Porter plant in Pittsburgh. He left the locomotive industry to take a position in the engineering department

of the Homestead steel works of Carnegie-Illinois Steel Company in November, 1917, and remained with the corporation until April, 1930, when he was made assistant chief engineer of the Wisconsin Steel works of International Harvester Company, which position he held until his recent appointment as chief engineer.

James McCulloch, veteran of 33 years service with the American Steel and Wire Company, was named superintendent of construction. Mr. McCulloch, in his new capacity, will have responsibility in the field for directing new construction and replacement of manufacturing facilities at the various plants of the company. A native of Scotland, he joined the wire company at its works in Donora, Pennsylvania, and spent 20 years there, rising to the position of field engineer. He spent two years in a similar position at Joliet, Illinois, and was transferred to company headquarters at Cleveland, Ohio, in 1937.

Frederick C. Keiser was named merchant products engineer for American Steel and Wire Company. Mr. Keiser will be identified with the merchant products section of the company's engineering department, which handles nails, fence, barbed wire, staples, and bailing wire. A native of Sharon, Pennsylvania, he attended schools in that city and joined American Steel and Wire at Farrell, Pennsylvania, in 1907, starting as a shipping clerk and advancing to the position of head draftsman. In 1935 he was transferred to Cleveland, where he has been a draftsman and designer.

Alexander S. Findlay has resigned from sales and service engineering with the Crocker-Wheeler Electric and Manufacturing Company and established his own electrical engineering design and consulting business

ALEXANDER S. FINDLAY

with an office in Youngstown, Ohio. Mr. Findlay was formerly with Carnegie-Illinois Steel Corporation, Youngstown district, as chief electrical engineer for many years.

A. B. Ordway was appointed to the executive staff of Kaiser Company, Incorporated. During the last four years Mr. Ordway has been vice president and general manager of the iron and steel division. Prior to that time and including some 36 years of service with Kaiser

SAVE TIME
On Every Job
WITH A
CLIPPER
MASONRY SAW

Cuts
- FIRE BRICK
- BUILDING TILE
- CONCRETE BLOCKS

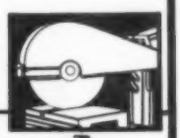
with

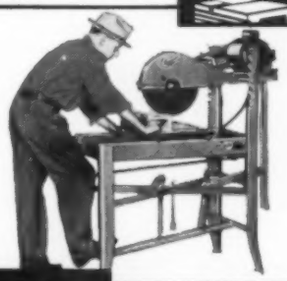
AMAZING *Speed* AND *Accuracy*

• You'll be amazed how quickly and easily you can cut virtually any special length or shape from the hardest masonry materials. Clippers save time — save material, assure better workmanship on every job.

Cuts DRY

Clipper's exclusive design is guaranteed to provide the highest economy with most rapid cutting speed. With or without foot pedal control.





Cuts WET

No dust. With foot pedal control or without. You can set the cutting head in locked position. The hardest materials cut with ease.

FAST *and* FLEXIBLE

The New Model HD-48 Clipper cuts dry just exactly the same as regular Clipper Masonry Saws.. and for Dustless masonry cutting just turn on the circulating system and slice thru the hardest materials. Proven by ten years use throughout the world. Guaranteed to provide the fastest cuts with lowest cost.

TAILOR MAKE SPECIAL SIZES

Yes . . . with a Clipper it's easy to slice thru Brick, Tile, Concrete, Glass, Marble, Porcelain or any kind of Refractories . . . Straight cuts, Angles or Mitres. CLIPPERS FOR EVERY JOB — Priced as low as $195. Write for Catalog Today!

TRY A CLIPPER FREE

THE CLIPPER MFG. CO.
11 EAST 28th ST. • KANSAS CITY 8, MO.
PHILADELPHIA CLEVELAND ST. LOUIS AUSTIN, TEX.

TIRED of oil soaked floors?

You don't have to put up with the fire and accident hazards of oil soaked floors or the waste of oil. Change to NON-FLUID OIL and let the results speak for themselves.

Drip-less, waste-less NON-FLUID OIL will stay in your motors and machines and off your frames and floors. Send today for instructive bulletin and free, testing sample of NON-FLUID OIL.

NEW YORK & NEW JERSEY LUBRICANT CO.

292 Madison Avenue, New York 17, New York
WORKS: Newark, N. J.
WAREHOUSES: Atlanta, Ga. - Greenville, S. C.
Charlotte, N. C. - Providence, R. I. - Chicago, Ill.
St. Louis, Mo. - Detroit, Mich.

NON-FLUID OIL is not the name of a general class of lubricants but is a specific product of our manufacture.

NON-FLUID OIL
TRADE MARK REGISTERED

interests, he has been an executive officer in many of the Kaiser affiliated companies, having been president of one for 14 years.

Otto G. Schwenk has been appointed vice president in charge of production of Yale and Towne Manufacturing Company. Before joining Yale and Towne, Mr. Schwenk was serving as assistant to the president of Weatherhead Company, Cleveland, Ohio.

J. C. Madson, general superintendent, Benson Mines, Jones and Laughlin Ore Company, Star Lake, New York, retired September 1. Mr. Madson had been with Jones and Laughlin Steel Corporation since November 1, 1913, having been connected with Inter-State Iron Company in Minnesota before taking charge of the Benson Mines operation in 1942.

William R. Webb, assistant general superintendent of Benson Mines, succeeded **J. C. Madson** as general superintendent. Mr. Webb came to Benson Mines from Blair Limestone Division, a subsidiary at Martinsburg, West Virginia, where he was production superintendent. Prior to his service at Blair Limestone, he served at Pittsburgh works as an open hearth metallurgical inspector and later as a research engineer on steel making at the Research Laboratory. Mr. Webb attended Lafayette College and the University of Pittsburgh.

John H. Owen is the newly appointed Chicago district sales manager of Harbison-Walker Refractories Company.

Charles B. Cleevely has been appointed assistant superintendent of maintenance for Youngstown Sheet and Tube Company, Campbell works, succeeding August C. Jacob who retired June 30. Mr. Cleevely joined the company in 1904 as a mail boy. Two years later he entered the engineering department as a blue print boy, tracer and detail. Three years later he became a draftsman, was made assistant foreman of crane repairs in 1915 and foreman of crane repairs in 1921, a position he held until his recent appointment.

Alwin F. Franz has been elected a director of the Colorado Fuel and Iron Corporation, Denver, Colorado. Mr. Franz is vice president in charge of operations for this corporation and its subsidiary companies.

W. L. Witney has been appointed to the new position of executive assistant to the vice president—operations for Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Mr. Witney began his service with Jones and Laughlin in 1924 at the Pittsburgh works. He has been chief industrial engineer since August 1, 1947.

E. G. Slocum, formerly assistant to the chief industrial engineer at Jones and Laughlin Steel Corporation, replaces **W. L. Witney** as chief industrial engineer for the corporation. Mr. Slocum is a graduate of the University of Michigan and has been with the corporation since 1943.

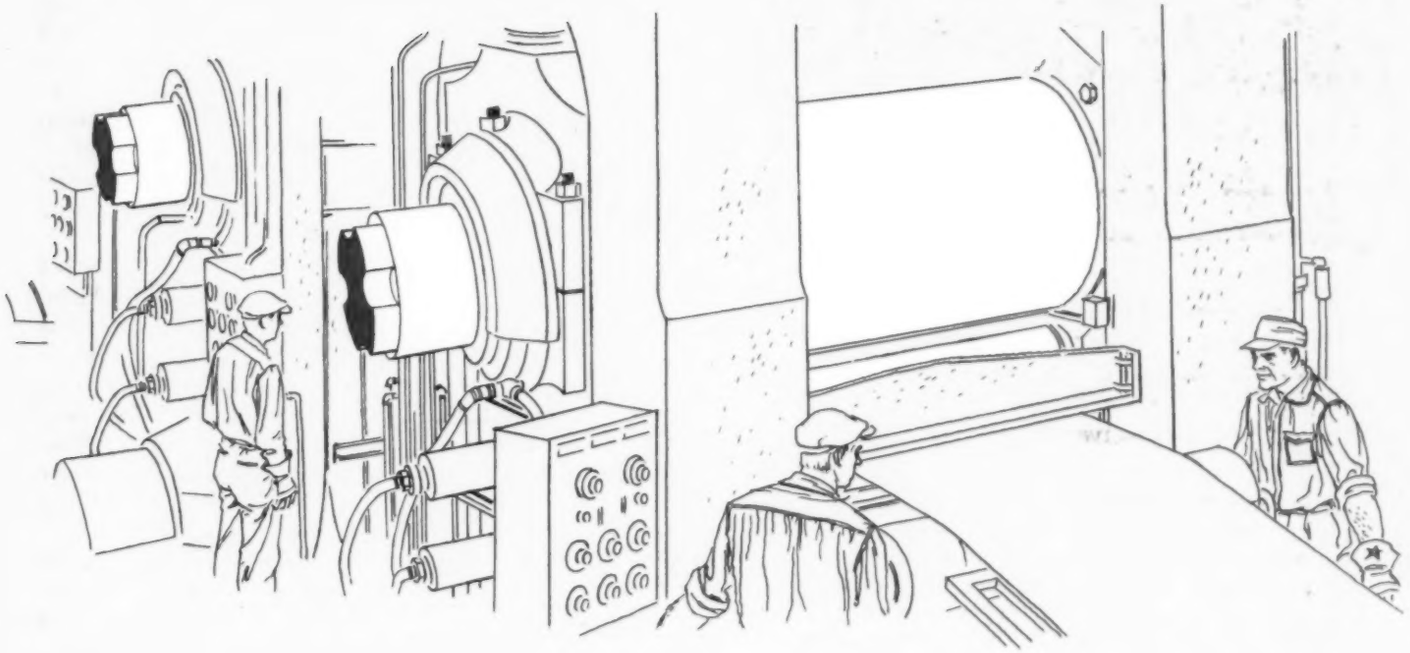
Eugene K. Graham was appointed assistant to the general superintendent of the steel works, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama.

Francis B. Harper was named superintendent of the 8, 10 and 12-in. bar mills of the Bethlehem Steel Company, Lackawanna, New York.

Allan W. Morton has resigned as vice president and general manager of the piston ring division, Koppers Company, Inc., Pittsburgh, Pennsylvania. Mr. Morton will remain as consultant to the new metal products

"I'll give you my Stetson if you can tell me what makes a roll spall—

Yes, sirree, I'll send a Stetson Hat
to the guy who writes me the best
answer. I ain't foolin'!"*
Ol' Red Wabbler



In the manufacture of Mackintosh-Hemphill rolls every possible precaution is taken to prevent spalling. Metallurgical and foundry practice at Mackintosh-Hemphill is based on the experience of Mill-wise Mack-Hemp engineers who work with your own rolling-mill operators.

Your purchase of Mackintosh-Hemphill Rolls—the rolls with the *red wabblers*—is your guarantee that your own operating practice will be the primary factor in determining the proper rolls for each stand.

MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

Makers of the Rolls with the Red Wabblers

OTHER MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: ROLLS . . . STEEL AND SPECIAL ALLOY CASTINGS . . . COMPLETELY INTEGRATED STRIP MILLS . . . HEAVY DUTY ENGINE LATHES . . . THE NEW MACKINTOSH-ABRAMSEN STRAIGHTENERS . . . IMPROVED JOHNSTON PATENTED CORRUGATED CINDER POTS AND SLAG HANDLING EQUIPMENT . . SHAPE STRAIGHTENERS . . . SHEARS . . . LEVELLERS.

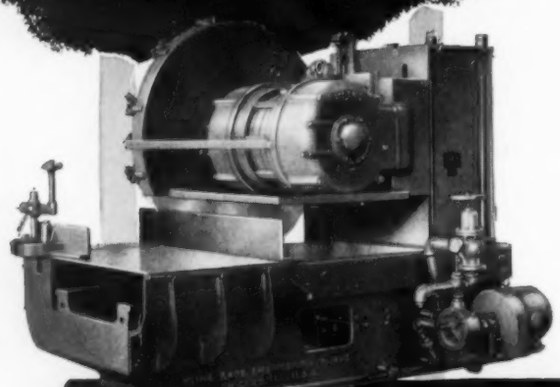
*

It's a fact!

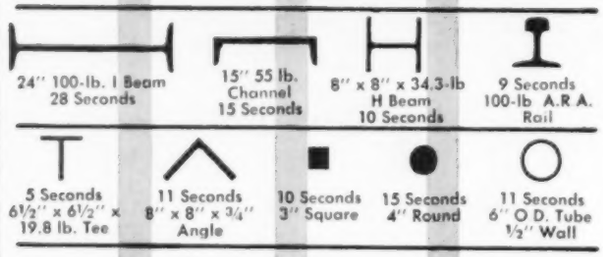
Just send me your opinion on spalling before November 1, 1948, and the best answer will get you a fine new Stetson.

Ol' Red Wabbler
Mackintosh-Hemphill Co.
Pittsburgh 3, Pennsylvania

Modern Sawing



with KLING HIGH SPEED FRICTION SAWS



Friction sawing is one of few mechanical processes which employ the heat of friction in a useful manner. It concentrates heat on the material to be severed at a rate which is faster than it can absorb heat. The immediate temperature rise of the contact surface is so great that its strength is reduced considerably lower than that of the colder blade rim. This heated surface is readily removed by the blade and permits complete severing of the material rapidly with no loss of metal from the blade.

Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or set-up, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.

Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.

KLING BROS. *Engineering Works*

Punches; Bar, Angle and Rotary Shears; Combination Shear, Punch and Copers; Plate and Angle Bending Rolls; Heavy Duty Grinders

1324 N. KOSTNER AVENUE, CHICAGO 51, ILLINOIS, U. S. A.

division. This new division was formed through the consolidation of the shock division and the piston ring division.

Howard B. Barr was recently named training manager for Columbia Steel Company, San Francisco, California.

Harry C. Taylor was appointed blast furnace superintendent at Globe Iron Company, Jackson, Ohio.

Douglas J. Munhall was named as sales representative for Pennsylvania Transformer Company in upper New York State. This includes Buffalo, Syracuse, Rochester, Albany, Binghamton, and surrounding territory. Mr. Munhall, a graduate of the University of Pennsylvania, was a sales engineer for the Union Car-

DOUGLAS J. MUNHALL

bide and Carbon Corporation in New York City and in Cleveland, Ohio. He spent some time in Chicago as a sales engineer, but recently returned to Buffalo where he organized the Douglas J. Munhall Company, 130 West Chippewa Street, Buffalo, New York.

Ora E. Clark has been appointed general superintendent of the Hamilton plant of Armco Steel Corporation. Mr. Clark succeeds **J. S. Ferguson** who was appointed technical director of the newly-formed Argentine division of the Armco International Corporation. With the exception of 2½ years in the army in World War I, Mr. Clark has spent his entire career in the steel industry. He took a position with the American Steel and Wire Company as a laboratory analyst immediately after graduating from high school, becoming assistant chief chemist of the plant. He joined the Pickands, Mather Company in 1915 as a chief chemist. In 1923 he became connected with the Donner Steel Company as blower foreman in the blast furnace department. He was made assistant superintendent of the department in 1926. He came to Hamilton as superintendent of the blast furnace department in 1927 when the local plant was being enlarged and modernized under the joint ownership of Armco and Koppers. On January 1, 1947, he was appointed assistant general superintendent of the Armco plant while continuing as superintendent of the blast furnaces.

John Poast was appointed superintendent of the blast furnace department, Armco Steel Corporation, Hamil-

ton, Ohio. Mr. Poast began working for Armco in 1933 in the metallurgical department at Middletown. He is a graduate of Ohio State University. In 1935, Mr. Poast was promoted to the position of special analyst in the Middletown Armco plant, retaining this position until 1940 when he was transferred to the blast furnaces at Hamilton as a metallurgical observer. He saw four years service as an artillery officer during World War II. Returning to Armco, he was subsequently promoted to junior metallurgist, assistant to the blast furnace superintendent, and in 1946 assistant superintendent of blast furnaces.

Walter C. Reed, after 20 years association as a development engineer in the laboratories of the General Electric Company, Pittsfield, Massachusetts, has recently announced his retirement. At the present time, Mr. Reed has established a consulting engineering office in Dalton, Massachusetts.

James B. Cunningham was appointed manager of the new Mansfield, Ohio, office of Ohio Equipment Company.

Jack L. Ashby was appointed to the position of vice president and general manager of the iron and steel division of Kaiser Company, Incorporated. Mr. Ashby has been associated with Kaiser Company, Incorporated for several years, serving in the capacity of general sales manager and more recently vice president and assistant general manager. This division operates the Kaiser Fontana steel plant.

R. J. Leckrone was appointed as vice president, in charge of engineering and sales, for Pittsburgh Engi-

R. J. LECKRONE

neering and Machine Company. This new company was formerly the machinery division of Pittsburgh Steel Foundry Corporation.

W. O. Fitzke, formerly steam engineer for Republic Steel Corporation at Canton, Ohio, has been named assistant mechanical superintendent.

Parker F. Wilson was elected president and director of the Kerotest Manufacturing Company at a recent meeting of the board of directors. A familiar figure in steel circles for more than twenty years, Mr. Wilson

At the Show See this

New

LINTERN

Aire-Rectifier

•

Basically Improved Yet Lower In Cost

To be shown for the first time at the Iron and Steel Show in Cleveland this year.

The culmination of eight years of unceasing research and unparalleled experience in the field of crane cab conditioning.

A basically different design which is vastly easier to install, saving time and cutting engineering and installation costs up to 30 per cent, while yielding even greater efficiency.

Stop at Booth 254 at the Show and see this remarkable, new design Aire-Rectifier in operation.

THE LINTERN CORPORATION

54 LINCOLN AVENUE BEREA, OHIO

has served in various executive capacities with Otis Steel Company, Wheeling Steel Corporation, and more recently as president of Pittsburgh Steel Foundry Corporation.

William P. Gillespie was appointed manager of a new market requirements department, for Henry Disston and Sons, Incorporated. Since 1944, Mr. Gillespie has been assistant manager of sales in the hardware division. Mr. Gillespie joined the Disston organization as a junior salesman in 1936, soon after his graduation from University of Pennsylvania's Wharton School, where he majored in merchandising. For the next three years he called on the trade, both retail and wholesale.

W. W. Sieg has been elected president of the Titan Metal Manufacturing Company, Bellefonte, Pennsylvania. He was formerly executive vice president of the company. He succeeds **W. P. Sieg,** who was appointed vice chairman of the board of directors and chairman of the executive committee. Other members of the executive committee include: **C. A. Cavanaugh, J. B. Graig, Claude F. Leaman,** and W. W. Sieg. The new president joined Titan Metal Manufacturing Company in 1929 as a metallurgist. He had previously been employed by Ingersoll-Rand Company, Philipsburg, New Jersey, and Rome Brass and Copper Company, Rome, New York. He is a graduate metallurgical engineer of the Pennsylvania State College.

J. C. McKenna, for the past six months product manager of chromium chemical sales for Diamond Alkali Company, Cleveland, Ohio, has been named product manager of alkali sales. He succeeds **J. D. Mattern,** who retired in mid-August after 25 years service with the company to make his home in San Diego, California. Mr. McKenna's successor is **Charles E. Grant,** assistant to the president of the Martin Dennis Company of Newark, New Jersey, since this manufacturer of chromium chemicals was acquired by Diamond earlier this year.

Dr. Lewis Warrington Chubb, director emeritus of the Westinghouse research laboratories, has retired after 43 years of scientific research with Westinghouse, leaving behind him a record of outstanding contributions in nearly every field of science and engineering.

The veteran scientist, who served as director of the laboratories from 1930 until assuming his honorary emeritus post last March, was awarded more than 150 patents covering inventions in radio, electronics, jet propulsion, telephony, electrical equipment, radar and many other fields. He has received nearly every major engineering and scientific honor.

Dr. Chubb joined Westinghouse immediately after being graduated from Ohio State University in 1905. In the years which followed he helped cut down high energy losses prevalent in electrical steels, and did im-

New! Special LOVEJOY couplings FOR D-C MILL MOTORS

LOVEJOY L-R NON-LUBRICATED

Visit with Lovejoy at the Annual AISE Convention and Iron and Steel Exposition, Cleveland, Ohio, Sept. 28 - Oct. 1.

Designed to latest AISE Standards

Lovejoy now presents an entirely new line of heavy-duty couplings precision-designed to meet all the requirements for D-C mill motors adopted by the AISE September 1947. These new couplings mark another step in the rugged, simplified Lovejoy engineering for each particular job. Engineers are cordially invited to get full details at the convention and Iron and Steel Exposition, in Cleveland.

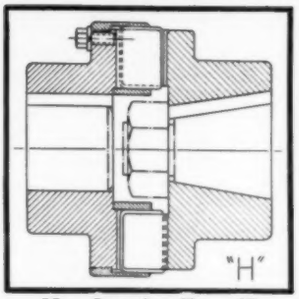
New Lovejoy Bulletin Will Be Available

Gives drawings and tabular information with data on load cushions, torque capacity and dimensions of couplings. These new couplings well exemplify the latest in Lovejoy engineering. For more than 20 years Lovejoy couplings have given the most satisfactory service in all types of heavy duty in steel mills, excavators and power plants.

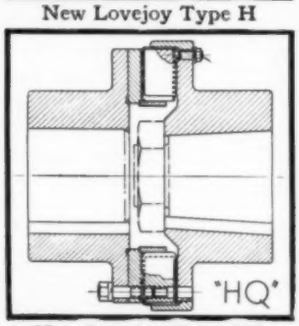
The complete Lovejoy line includes couplings for every duty, ⅛ to 2500 h.p.

Pittsburgh Representative

EDWARD J. BOYLE COMPANY
7702 Edgewood Ave., Pittsburgh, Pa.



New Lovejoy Type H



New Lovejoy Type HQ

LOVEJOY FLEXIBLE COUPLING CO. 5016 West Lake St., Chicago 44, Illinois

WHEN
THIS HAPPENS
PRODUCTION DROPS . . .
AND YOUR COSTS RISE . . .

Derailments Are Costly.

We are engaged in both construction and maintenance of railroad side tracks. Our organization has thoroughly trained former railroad personnel. They all have had years of track-laying and maintenance experience.

We are equipped to survey your track layout; then set up a complete program for the necessary repairs, rehabilitation and future maintenance.

RAILROAD SIDING CONSTRUCTION CO.
507 TRIANGLE BUILDING
PITTSBURGH 22, PA. GRant 1049

The Answer
TO YOUR PIPE CLEANING PROBLEM

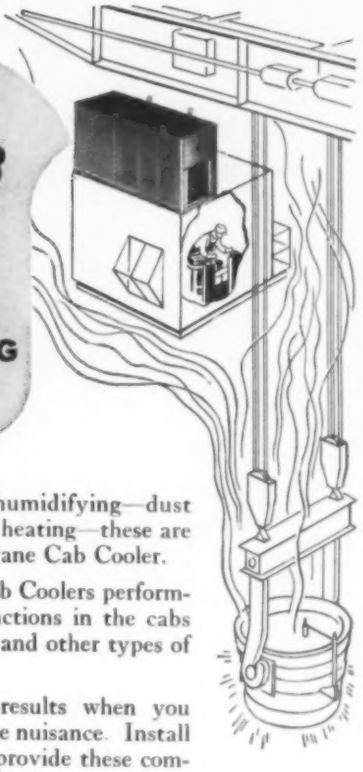
We offer a pipe cleaning service that will cost you much less than you can do it yourself. Our service covers all types of pipes, and we use both mechanical and hydraulic cleaning systems. We are prepared at all times with special equipment and trained experts to meet any particular pipe cleaning problem you may have.

Many of the leading industrial organizations who are already using this service exclusively, say it is the answer to their pipe cleaning problems. Case histories and names will be furnished upon request.

SERVICE · EQUIPMENT · KNOW HOW

EASTERN PIPE MAINTENANCE COMPANY
507 TRIANGLE BUILDING
PITTSBURGH 22, PA. GRant 1002

DRAVO CRANE CAB COOLERS
PERFORM EVERY AIR CONDITIONING FUNCTION



Cooling—fume removal—dehumidifying—dust filtering—ventilating—winter heating—these are the functions of the Dravo Crane Cab Cooler.

You will find Dravo Crane Cab Coolers performing these air conditioning functions in the cabs of soaking pit, ladle, stripper, and other types of hot-metal cranes.

And you will observe real results when you eliminate heat fatigue and fume nuisance. Install Dravo Crane Cab Coolers to provide these comfortable working conditions in the cabs of hot-metal cranes.

DRAVO CORPORATION
PITTSBURGH · PHILADELPHIA · CLEVELAND · NEW YORK
CHICAGO · DETROIT · ATLANTA · BOSTON
Sales Representatives in Principal Cities

DRAVO

PARTICULAR CUSTOMERS

are not Fussy...

IF you desire to avoid delays due to poor quality and poor deliveries, PLACE YOUR ORDERS WITH FALCON

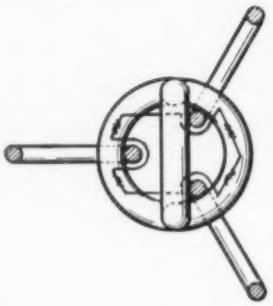
IF you are a discriminating buyer, one who requires excellence in quality, service and delivery, PLACE YOUR ORDERS WITH FALCON.

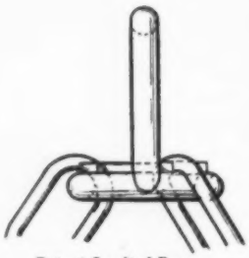
IF you expect flawless castings in record time, PLACE YOUR ORDERS WITH FALCON.

FALCON'S part in blast furnace and steel mill operations, since its establishment in 1890, has been to provide such specialized services on all non-ferrous casting needs.

TELEPHONE COLLECT - 3-4355
FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 • Incorporated 1895

LONG LIVED
Frictionless
Magnet Suspension Chains





Suspension Chains for 55" and 65" Lifting Magnets that eliminate friction, so will last 3 times as long as old-fashioned Suspensions because:

1st: Each leg hangs free on ring and in magnet ears with no twisting or rubbing.

2nd: Suspension is made of high alloy steel — **heat-treated:** periodic annealing not necessary.

3rd: Each 55" Suspension is tested to 89,000 pounds; each 65" Suspension is tested to 115,000 pounds.

Note: Locating Plate keeps legs at 120° centers.

Patent Applied For

Prompt shipment from stock.

DOWNTOWN COMPANY
1836 Euclid Avenue CLEVELAND 15, OHIO

Since the days when Charlie Schwab signed orders for them, Smeeth-Harwood Hot Blast Valve Seats have been the recognized Standard of Dependability.

Today they are better than ever before—thanks to moulding and melting techniques developed and perfected thru the years.

Send your next order for Hot Blast Valve Seats to Smeeth-Harwood. The superior quality means longer, more dependable service at no extra cost.

SMEETH-HARWOOD COMPANY
2401-09 West Cermak Road, Chicago 8, Illinois
Superior* Blast Furnace Copper Castings *Exclusively.

portant work in high temperature insulation. His novel electro-percussive method of welding, still in use today, revolutionized the field of welding. He obtained the first American patent on grid-controlled arc inverters and vacuum oscillators. Dr. Chubb helped found the Westinghouse research laboratories in 1916. In 1920 he was named head of all the company's radio engineering activities, and he figured prominently in the establishment of KDKA, the world's pioneer broadcasting station.

During World War II, he was active in the development of jet propulsion, microwave apparatus, new types of torpedoes, fire control systems, and high-temperature alloys Dr. Chubb was consultant on numerous important committees charged with the development of new military equipment and weapons, including the atomic bomb.

Last year Dr. Chubb was awarded the John Fritz medal, the nation's highest tribute to scientists and engineers.

Gilbert B. Richards has been appointed general sales manager of Firth Sterling Steel and Carbide Corporation with headquarters at McKeesport, Pennsylvania, to co-ordinate the sales of the steel, carbide and toolmaking divisions of the company. Mr. Richards was formerly general sales manager of Bostitch, Incorporated, Westerly, Rhode Island, and previously commercial sales manager for Firestone Tire and Rubber Company.

Henry V. Bootes, formerly district sales manager, New York sales district, has been appointed assistant vice president of American Car and Foundry Company, it was announced by Frederick H. Norton, vice president in charge of sales for ACF. Mr. Bootes will continue to make his headquarters in New York.

Prior to coming to ACF in 1947 he was district manager of Ohio Injector Company, manufacturers of railroad equipment.

Hobart C. McDaniel has been appointed manager, technical press service in the Public Relations Department of Westinghouse Electric Corporation, Pittsburgh, Pennsylvania. Mr. McDaniel will be responsible for the company's publicity in the technical and trade magazines. He will succeed **Carl E. Nagel** who has resigned to join McGraw-Hill Book Company in New York as editor of mail sales books for the engineering and industrial fields. Mr. McDaniel was graduated in electrical engineering from Oregon State College, Corvallis, Oregon, in 1926. He went with the Westinghouse Lamp Division in Bloomfield, New Jersey, as commercial engineer in 1939 after working with Pacific Power and Light Company, Portland, Oregon, and Central Illinois Public Service Company, Springfield, Illinois, as a lighting sales engineer. In 1943 he joined the technical press service in the Pittsburgh office.

M. A. Follansbee was elected executive vice president of Follansbee Steel Corporation, Pittsburgh, Pennsylvania. Mr. Follansbee started in the operating division in 1913 and has been with Follansbee company since that time except for a period of service during World War I. He was elected a director in 1940 and in 1941 was elected vice president of sales, a position he will continue to hold in addition to his new responsibilities as executive vice president.

D. J. Erikson has been elected president of the Hagan

D. J. ERIKSON

Corporation, Pittsburgh, Pennsylvania. Mr. Erikson formerly was vice president in charge of sales.

M. J. Boho was appointed vice president of sales of Hagan Corporation, Pittsburgh, Pennsylvania. Mr. Boho was appointed assistant general manager of sales

M. J. BOHO

in August, 1944. Before joining Hagan Corporation in 1936 as a sales manager, Mr. Boho had been two years with Bailey Meter Company and three years at the Potomac Electric Company, Washington, D. C. Mr. Boho is a graduate of the engineering college of Lafayette University.

John C. Murray has been appointed assistant to the Youngstown district manager, Republic Steel Corporation. Mr. Murray was formerly with Jones and Laughlin Steel Corporation, having joined that company in 1915. In 1929 he was named junior assistant general superintendent of the Pittsburgh works, and in 1935 became senior assistant.

Jack R. Gregson was appointed district sales manager of the bucket department of Wellman Engineering Company in the eastern territory. Mr. Gregson will maintain his headquarters at 420 Lexington Avenue, New York, New York.

• SPECIALISTS IN *CHEMICAL-PROOF* CONSTRUCTION

INCREASE TONNAGE PICKLED WITH Heil STEAM Jets

E-4 Jet for Sheet Pickler.

E-3 Jet for Continuous Pickle. Insert; Flanged Section.

• Reports show increases in tonnage pickled from 20% to 40%. Savings in acid consumption also reported.

Our complete series of jets have been designed to give thorough heat and agitation to any or all parts of the pickling vat. Write Dept. J for free Bulletin No. 43.

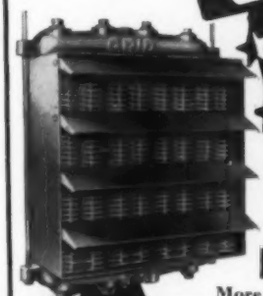
SEE OUR BOOTH No. 310

PICKLE TANKS • HEATERS • CRATES

Heil PROCESS EQUIPMENT CORP.
Formerly Heil Engineering Company
12901 ELMWOOD AVE. • CLEVELAND 11, OHIO

GRID

GRID HIGH TEST ALLOY CAST IRON UNIT HEATERS — BLAST COILS — RADIATION — for the IRON & STEEL INDUSTRY



ONE PIECE HEATING SECTIONS

More "free" area per foot of heating surface in GRID than in any other equipment of its type on the market today . . . no clogging or plugging due to atmospheric conditions. GRID Unit Heaters are designed for lower outlet temperatures and more air delivery to the floor line — not the ceiling . . . and they withstand high corrosive atmospheres. GRID Unit Heaters are safe to operate on steam pressures up to 250 lbs. Used over 17 heating seasons without maintenance.

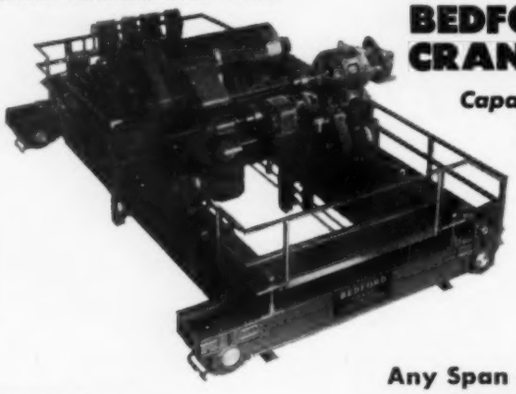
GRID BLAST COILS

For outside air, drying, process work, etc., GRID Blast Coils have the same high efficiency and lasting qualities as GRID Unit Heaters . . . no tortuous air passages . . . constructed to permit freedom of expansion with complete absence of ruptures, strains, and warping. Compact in design, GRID Blast Coils occupy less space than other types of cast iron blast coils of equal capacity.

Ask for complete details and capacity tables.

D. J. MURRAY MANUFACTURING CO. WAUSAU WISCONSIN

CRANE BUILDERS Since 1903



BEDFORD CRANES

Capacities 5 to 150 Tons

Designed and Engineered to Meet Your Requirements

Any Span or Lift
Send For Your Copy Of Catalog

ELECTRIC OVERHEAD TRAVELING CRANES
GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS

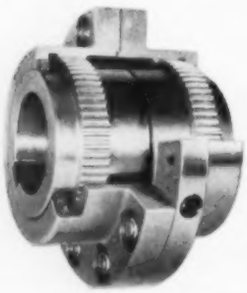
BEDFORD FOUNDRY & MACHINE CO.

Engineers
Designers
Fabricators

BEDFORD, INDIANA
U. S. A.

Gray Iron Castings

REMEMBER THIS ABOUT COUPLINGS



there are gear types —and there's the

WALDRON *Improved* **Gear Type**

Designed To Permit Use Of Larger Shafts and Equipment

The *improved* WALDRON gear type is distinguished from the ordinary gear types by the many extra operating advantages built into its new design — advantages that you will recognize instantly.

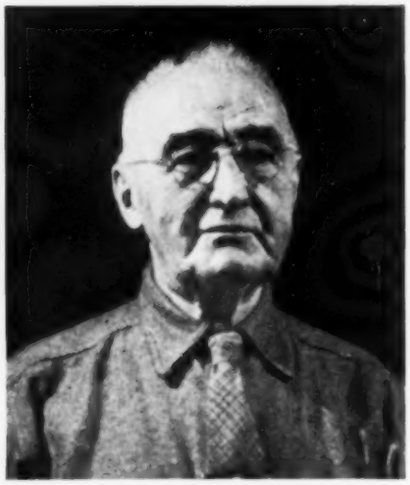
For ratings, service factors and other details, write for Catalog 57.

JOHN WALDRON CORP.
Main Office and Works
New Brunswick, New Jersey
COUPLINGS

Sales Representatives in Principal Cities.

Obituaries

Louis C. Bonnot passed away on August 29 at his home near Canton, Ohio. Born nearly a century ago in 1858, Mr Bonnot long was nationally known as an equipment and design engineer. Mr. Bonnot's machine



LOUIS C. BONNOT

developments were chiefly in rotary kilns, coolers, dryers, crushing, pulverizing and extruding equipment. B. T. Bonnot a nephew, now is president and general manager and at the age of 93, John, a brother of Louis Bonnot, and father of B. T. Bonnot, still is active in the company which they helped found in 1878.

A. F. Dohn, 72, director and honorary vice president of Allegheny Ludlum Steel Corporation, died recently after suffering a heart attack. "Al" Dohn, as he was affectionately known by makers and users of machine tools the country over, retired as vice president in charge of tool steel sales for Allegheny Ludlum in 1941 after more than 30 years as one of the nation's outstanding steel salesmen.

George Harley Criss, 67, died August 16. Mr. Criss was a manufacturers' representative for several years handling several companies. He had previously been employed by the H. E. McCoy Company and the Westinghouse Electric Corporation. Mr. Criss was a 1905 graduate of the University of Pittsburgh engineering school.

Herbert C. Greer, 71, president, Greer Steel Company, Dover, Ohio, died August 5.

James P. Dovel, 79, formerly vice president and consulting engineer of Sloss-Sheffield Steel and Iron Company, Birmingham, Alabama, died recently.

William Harold Riddell, 54, president of Riddell Engineering Company, Incorporated, Birmingham, Alabama, died August 3.

GIANT STEEL CASTINGS *and* CUT GEARS *by* NE

Ajax Super Tube Upsetter with Neloy Spur Gear and Pinion and V Belt Flywheel Drive.

V Belt Flywheel Drive.

VITAL PARTS IN DRIVE OF THIS 580,000 lb. AJAX SUPER TUBE UPSETTER

THE gear, pinion, V-belt flywheel drive for clutch assembly of this giant production machine were cast and machined at National-Erie. The gear is .40-.50 carbon steel, 127 inch diameter with 14 inch face. The pinion is Neloy alloy steel; rough turned, heat treated and hardened; finish machined . . . then the teeth are flame hardened. The V-belt flywheel drive is .40-.50 carbon steel, rough weight 25,640 pounds.

This drive mechanism is typical of routine at National-Erie Corporation. Here under one control and with one responsibility from raw materials to finished products, gears and castings of Neloy and Neloy Moly steels are turned out to your specifications for dependable service in the machines of industry. Consult with our engineers . . . let us help you in meeting your gear and casting requirements.

NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.

"MEASURING UP"...

from every angle

There's no chance of misfits in International graphite electrodes and nipples. They are checked chemically and mechanically, for top-quality and constant uniformity.

Carbon and binder ratios are constantly tested to assure highest degree of purity. Baking and graphitizing cycles are carefully controlled to produce a high grade product. Threads, ID and OD, circumferences and lengths are put to caliper and micrometer examinations. If they don't "measure up"—you don't get them.

Now International graphite electrodes come to you in palletized shipments that mean time and money savings in unloading boxcars and gondolas. Write today for a free copy of the Graphite Engineering Data Book.

International Graphite & Electrode Corp.

SAINT MARYS, PA

Foundry cuts annealing and firing time practically in two!

How Johns-Manville Insulating Fire Brick enables 6 new furnaces to do work formerly requiring 12

This is the story of a foundry that called on Johns-Manville Insulation Engineers about the plans for their new annealing furnaces.

The company had been operating 12 furnaces constructed with heavy fire brick. One of these furnaces was rebuilt, for test purposes, with insulating materials recommended for the job by Johns-Manville Insulation Engineers. After the furnace was completed, exhaustive operating tests were made and results were compared with the old furnaces.

Test Results

The old furnaces in this foundry performed with an average annealing cycle of 120 hours. The new furnace made it possible to cut the annealing cycle to as low as 72 hours.

Partially completed furnace with J-M materials ready for installation.

The firing time was 80-100 hours depending upon the quality of fuel available. Average firing time in the new furnace was cut to 40 hours.

These results were so striking that the management decided to build 5 additional furnaces of similar construction.

The 6 new furnaces, as engineered by Johns-Manville, are expected to fill all production needs of the plant—replacing entirely the 12 old-style furnaces—resulting in doubled operating efficiency.

Materials Used

The furnace walls were built with thirteen and a half inches of JM-23 Insulating Fire Brick. In every fifth course, vertically, a header row of brick was used with a stretcher course of brick to tie the wall into a solid unit.

To further decrease the heat transfer through the walls, a combination of 2″ thickness of J-M Superex Blocks and 1″ thickness of 85% Magnesia Blocks was used between the insulating brick walls and the outer steel casing.

The arch was constructed with a 9″ thickness of JM-26 Insulating Fire Brick. Over this, 5 inches of Sil-O-Cel Natural Brick was installed in two 2½″ layers. That part of the arch subject to abrasion from the powdered fuel is constructed of fire brick. In order to keep the heat transfer approximately uniform over the entire arch area, that portion constructed of fire brick was backed with a 2½″ thickness of J-M Superex Blocks. And, over this, five inches of Sil-O-Cel Natural Brick was applied.

Cutting J-M Insulating Fire Brick on the job.

J-M 1626 cement was used as bonding agent.

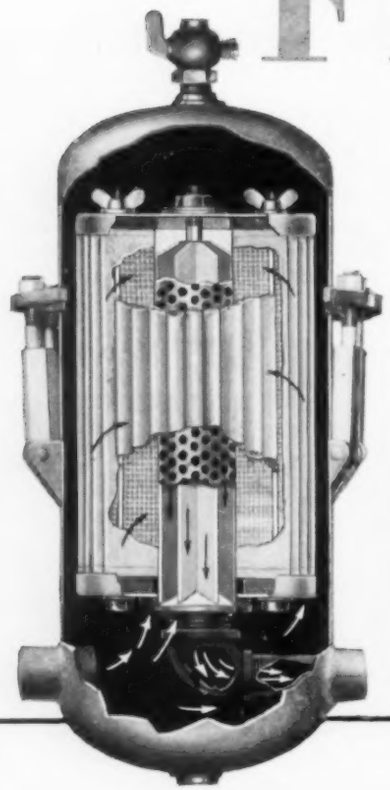
The furnace bottom was insulated first with a 4″ thickness of Sil-O-Cel C-3 concrete. Over this base, ten inches of Sil-O-Cel C-22 brick were laid. A 4″ course of paving brick supplies the wearing surface for the high load-bearing insulating material used for the furnace bottom.

Engineering Service

The same service performed by J-M Insulation Engineers in selecting the right combination of insulating materials to increase efficiency for this plant can be made available to you. Write Johns-Manville, Box 290, New York 16, New York.

JOHNS-MANVILLE JM PRODUCTS

Have You a Problem in Liquid Filtration?



STAYNEW MODEL ELS LIQUID FILTER

Tested and Approved by Users Everywhere

SLIP-ON INSERT

The most versatile liquid filter ever developed. Design permits use of any filtering medium available in sheet form that can be crimped. Exclusive SLIP-ON INSERT of original Radial Fin Construction permits simple and inexpensive replacement or cleaning of medium on the job.

DURING THE PAST 10 YEARS, Dollinger Corporation engineers and laboratory technicians have solved literally hundreds of tough liquid filtration problems for industry. Media covering a wide range of types and materials ranging from fine wire meshes in various metals and alloys thru fabrics, plastics, ceramics and minerals have been tested and adapted for use in handling a comprehensive list of liquids. Many entirely new ideas and concepts have been developed, and the information indexed for quick reference.

This unsurpassed fund of knowledge in the highly specialized field of liquid filtration is yours for the asking. Either write, c/o Dollinger Testing Laboratory, stating your problem, or ask for Bulletin D-1L. This Bulletin completely describes and illustrates the various Staynew Liquid Filters and offers a convenient CHECK LIST for use in submitting your problem.

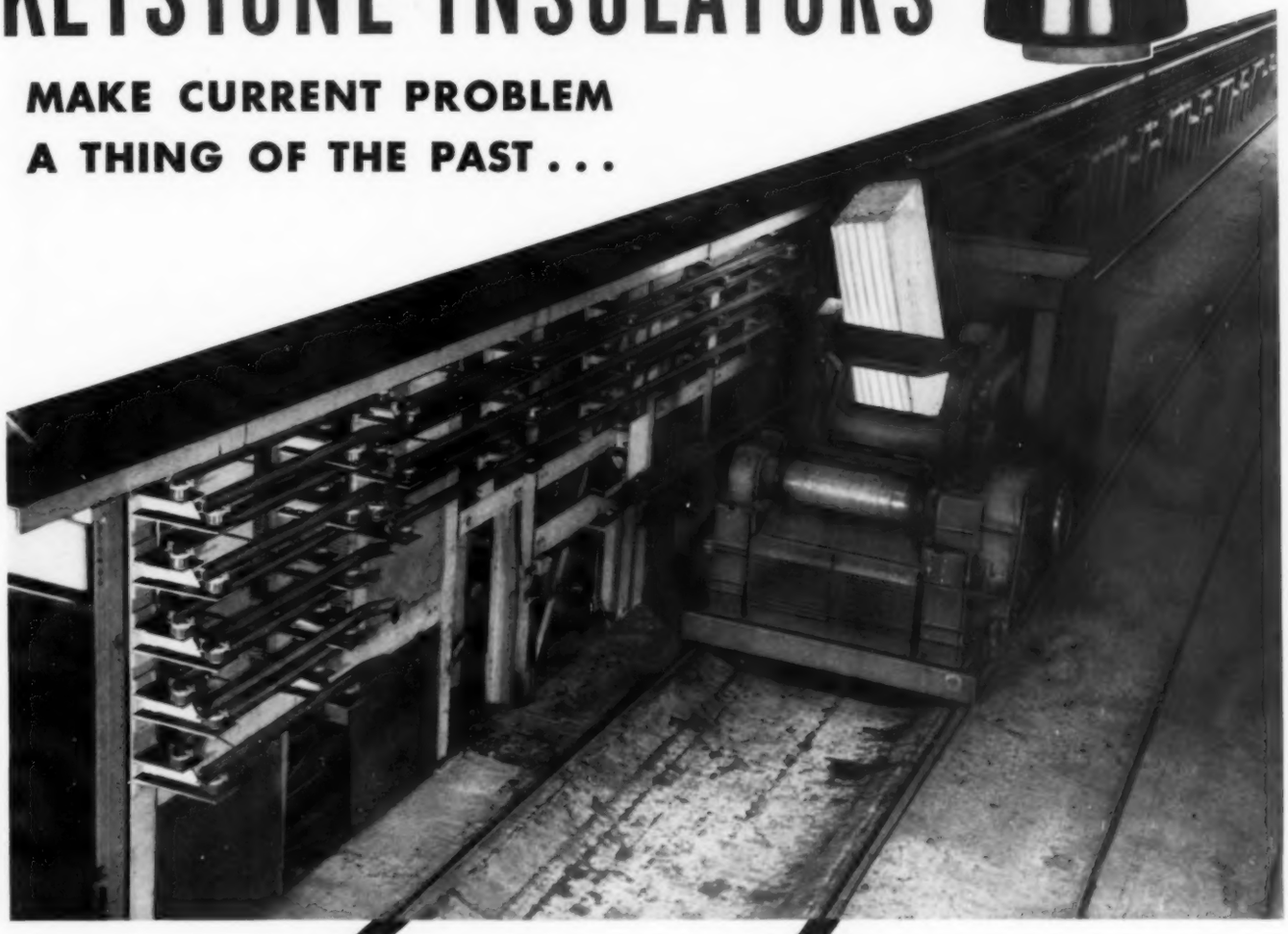
DOLLINGER CORPORATION

16 CENTRE PARK, ROCHESTER 3, N. Y.

DOLLINGER REG. PROTECTOMOTOR U.S. PAT. OFF. STAYNEW FILTERS

KEYSTONE INSULATORS

MAKE CURRENT PROBLEM A THING OF THE PAST . . .



At Carnegie Illinois Steel

To carry hot ingots from soaking pits to slabbing mill, the Carnegie Illinois Steel Corporation uses electrically powered buggies. Current for these buggies must be maintained under rugged operating conditions created by constant usage and high temperatures.

That's where the Keystone Contact Rail Insulator, Type DDI, proved to be so valuable. Through its heavy glazed, semi-porcelain block, it provides reliable support and insulation of the contact rails. A malleable iron cap cemented to the block is equipped with adjustable lugs which are adaptable to standard rails from 30 to 65 lbs. Installation is easy and rapid. Mounting is accomplished with a single bolt. All metal parts are hot galvanized. Made of high quality materials by skilled craftsmen, Type DDI was the answer for Carnegie Illinois Steel.

For your cranes, conveyors, or other electrical hoisting and hauling systems, Electric Service manufactures a complete line of insulators, collectors, and rail shoes. Used with rails, angles, or wires as a conductor, they assure the constant contact necessary for dependable transmission of power.

Details are available in our free, illustrated catalog. Write for your copy.

ELECTRIC SERVICE MANUFACTURING CO.

Keystone INDUSTRIAL PRODUCTS

1721 CAMBRIA ST • PHILA. 32 • PA. • *Branches in Principal Cities*

SHORT IN COST...
L-O-N-G IN SERVICE...

This MONEL Pickling Crate has been on the job for 13 years

THE Follansbee Steel Corporation of Follansbee, W. Va., wanted a pickling crate . . . one that would carry a two-ton load of high silicon electrical steel sheet . . . one that would last a long time with a minimum of upkeep expense.

They chose MONEL* as the fabricating material; chose it because of MONEL'S exceptional resistance to hot acids and its steel-like strength. And a wise choice it was, for today *—13 years later*—the MONEL pickling crate is still in service!

During war years, when ever more production was needed, the MONEL pickling crate carried a double load of armor plate: 4 tons instead of 2. Yet, even with this increased burden, the crate more than lived up to expectations.

This is but one of thousands of instances where MONEL has shown its outstanding superiority under severely corrosive conditions.

In addition to high strength and corrosion-resistance, MONEL offers *workability*. MONEL can be fabricated by ordinary shop methods without special tools or equipment. MONEL can be welded. And what is extremely important—welded MONEL seams are corrosion-resistant.

Check your own plant installations today. You may find many places where the versatile INCO Nickel Alloys can save you money. For further information, contact your nearest INCO distributor. He will gladly help with your metal selection problems. *Reg. U. S. Pat. Off.

DISTRIBUTORS

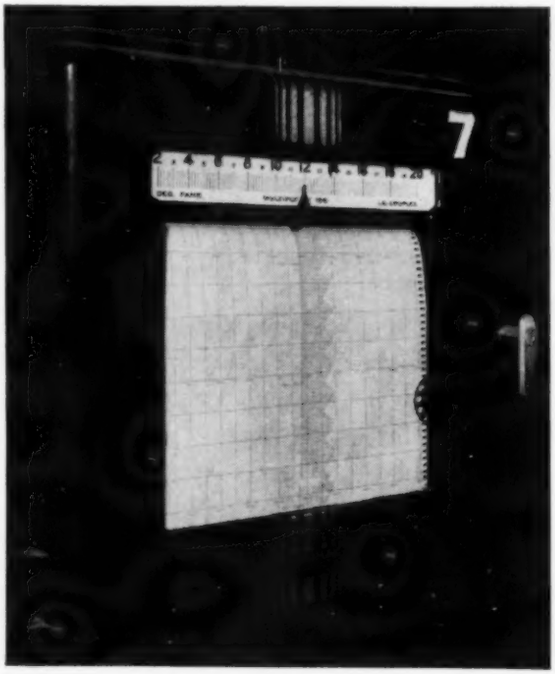
WHITEHEAD METAL PRODUCTS COMPANY, INC.
Baltimore-Boston-Buffalo-Cambridge-Newark-New Haven-New York-Rochester
WILLIAMS and COMPANY, INC.
Cincinnati-Cleveland-Columbus-Pittsburgh-Toledo
STEEL SALES CORPORATION
Chicago-Detroit-Indianapolis-Milwaukee-Minneapolis-St. Louis
PACIFIC METALS COMPANY, LTD.
Los Angeles-Salt Lake City-San Francisco
J. M. TULL METAL & SUPPLY CO.
Atlanta
METAL GOODS CORPORATION
Dallas-Denver-Houston-New Orleans-Tulsa
EAGLE METALS COMPANY
Portland-Seattle-Spokane
ROBERT W. BARTRAM
Montreal
ALLOY METAL SALES, LTD.
Toronto
WILKINSON COMPANY, LTD.
Vancouver

MONEL
FOR MINIMUM MAINTENANCE

EMBLEM OF SERVICE
INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Some of the 40 cover furnaces at Great Lakes Steel Corp., Detroit, Michigan. Center, stacks of flat sheet stand ready for heating; right, completely assembled cover furnaces carry on the annealing process; left, inside covers protect the annealed steel during cooling.



This Micromax record demonstrates one type of control. Irregular right margin shows the fluctuating temperature at the roof, as fuel is turned on and off. Left margin shows regular increase in temperature of the work.

Annealing Covers at Great Lakes Get Accurate MICROMAX Control

To help take full advantage of the economies possible with forty cover furnaces annealing a tremendous output of sheet and coil steel, Great Lakes uses Micromax pyrometers for the temperature control part of the job.

Temperature cycles for some of the heating operations are fairly complicated. Sometimes the controller must bring the work up to temperature smoothly and efficiently and hold it at soak temperature for exactly the prescribed period. For cycles like malleablizing or spheroidizing, Micromax also controls the cooling rate. Great Lakes is equipped to accomplish almost any variation of the basic annealing cycle, and Micromax Control handles all requirements.

Program Control effects substantial improvements in fuel economy and product quality, because it regulates valve movement at the most critical times — when furnace temperature is changing at a predetermined rate.

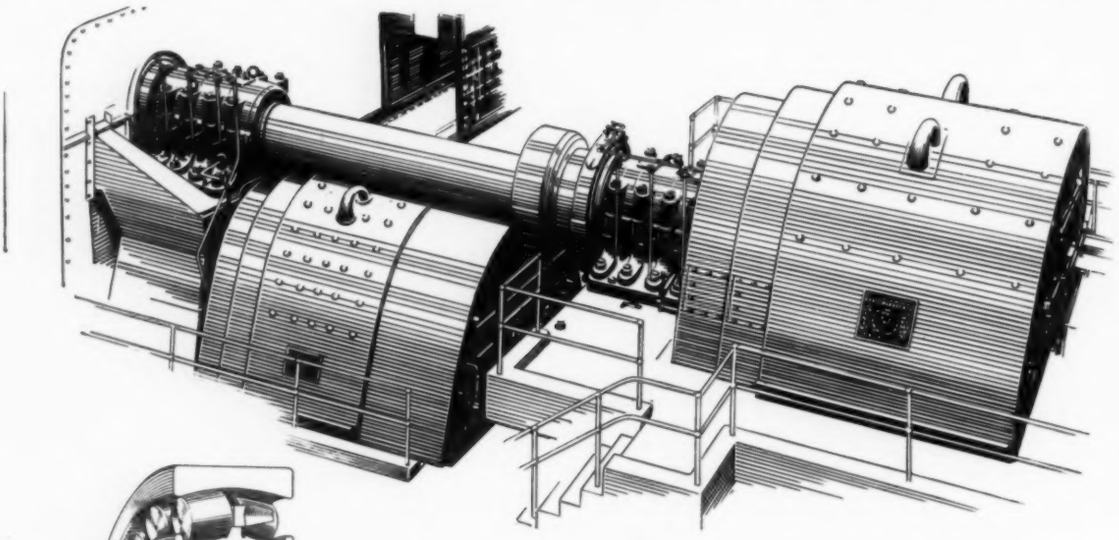
Whatever your heat-treating requirements, Micromax can help. For specific information on how it can answer your needs, write to Leeds & Northrup Company, 4942 Stenton Avenue, Philadelphia 44, Pennsylvania.

LEEDS & NORTHRUP

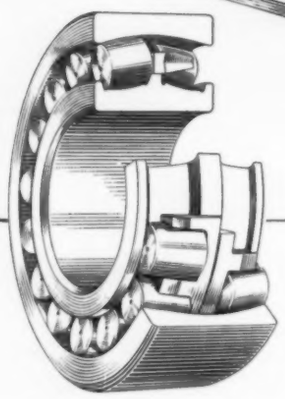
MEASURING INSTRUMENTS · AUTOMATIC CONTROLS · TELEMETERS
HEAT-TREATING FURNACES

Jrl. Ad N-33A-626 (5)

Gear Drives Mesh Smoothly with Torrington Spherical Roller Bearings



Steel mill gear drives equipped with Torrington Spherical Roller Bearings operate at higher speeds under heavier loads with maximum accuracy, minimum wear.



... these self-aligning units carry thrust in both directions, preventing end-play of shafts, assuring accurate meshing of gears.

Steel mill gear drives equipped with Spherical Roller Bearings transmit power smoothly – with minimum wear of bearings and gears.

The low friction coefficient and precision construction of these heavy-duty bearings insure smooth operation. Automatic compensation for misalignment prevents undue stress of bearing elements under shaft deflection. Because of the high radial capacity and ability of Spherical Roller Bearings to carry thrust loads in either direction a minimum of maintenance attention is required.

Torrington Spherical Roller Bearings are providing longer service life in many types of steel mill auxiliary equipment such as gear drives, pinion stands, table rolls, coilers, reels, tension rolls, screw downs, truck wheels and cranes.

Let a Torrington engineer make recommendations on selection and design of anti-friction bearings for your heavy-duty equipment. Call or write the nearest Torrington office.

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities

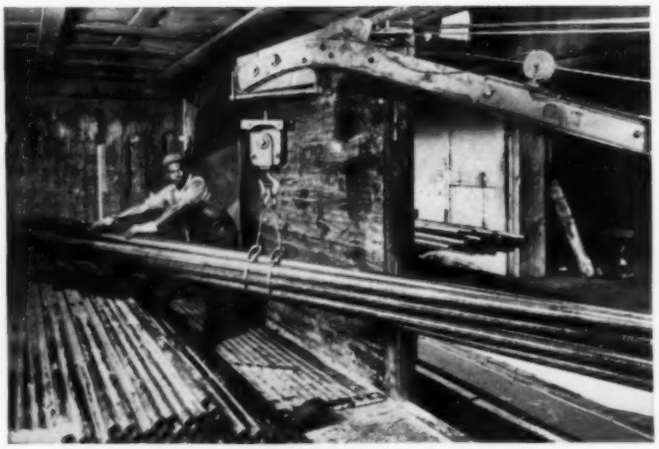
TORRINGTON *SPHERICAL ROLLER* **BEARINGS**

SPHERICAL ROLLER · TAPERED ROLLER · STRAIGHT ROLLER · NEEDLE · BALL · NEEDLE ROLLERS

96 MAN HOURS CUT TO 32— WITH BAKER TRUCK

Crane Truck at NATIONAL ACME CO. pays for itself in 8 months

This Baker Crane Truck, unloading 20-ft. steel tubes each weighing 260 lbs., cuts man hours by 2/3 over former methods. Actual savings — as shown in tables below — are even greater than estimates made before the truck was purchased:



(Above) Boom of Baker Crane Truck leaving box car with load of ten 2¾" x 20 ft. steel tubes.

(Below) Baker Crane Truck loading tubes onto trailer. Each tube weighs 260 lbs., load weighs 2600 lbs.

A Baker Material Handling Engineer can show you how to make similar savings

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Co.
2166 WEST 25TH ST. CLEVELAND, OHIO
In Canada: Railway & Power Engineering Corporation, Ltd.

Man Hours per car — Previous Methods

96 MAN HOURS

Remove blocking from car	0.5 hrs. x 4 men	2.0
Unload to trailer 100,000 lbs.	11.0 hrs. x 4 men	44.0
Clean car	0.5 hrs. x 4 men	2.0
Haul to storage Unload from trailer to pile Return empty trailer	12.0 hrs. x 4 men	48.0
Total man hours		96.0

Estimated Man Hours with Baker Truck

45 MAN HOURS

Remove blocking from car	1.0 hrs. x 2 men	2.0
Unload to trailer 100,000 lbs.	11.0 hrs. x 2 men	22.0
Clean car	1.0 hrs. x 2 men	2.0
Haul to storage Unload from trailer to pile Return empty trailer	9.5 hrs. x 2 men	19.0
Total man hours		45.0

Actual Man Hours with Baker Truck

32 MAN HOURS

Remove blocking from car	0.5 hrs. x 2 men	1.0
Unload to trailer 100,000 lbs.	7.0 hrs. x 2 men	14.0
Clean car	0.5 hrs. x 2 men	1.0
Haul to storage Unload from trailer to pile Return empty trailer	8.0 hrs. x 2 men	16.0
Total man hours		32.0

National Acme Co. is making comparable savings on other handling operations with Baker Trucks. This illustration shows a Baker Fork Truck moving a box of finished bushings weighing 3130 lbs. from production directly to railroad car for shipment.

Baker INDUSTRIAL TRUCKS

Powder-Cutting

Steps Up Production of Stainless Steel Castings 32 Times . . .

Centrifugally-cast rings of stainless steel are cut in 15 minutes time, increasing production 32 times.

Riser cutting of centrifugally-cast stainless steel rings used to be a difficult and time-consuming job. In one foundry which used a boring machine, this operation took eight hours per casting. When powder-cutting was introduced, the time was reduced to approximately 15 minutes—a 32-fold increase in production.

In another foundry, powder-cutting was profitably used to remove ⅜ to 1 in. of metal from stainless steel castings. The machining cost for this type of work has been $24.00 per casting. Substitution of powder-cutting brought the overall cost, including finish-grinding and chipping, to $7.53 per casting, and reduced the time from 8 hours to 1 hour. For an order of 60 castings, the foundry saved $988.20 and 360 hours of operating time.

If you have stainless steel or other oxidation-resistant metals to cut, LINDE's service engineers can show you how powder-cutting methods can be used with profit. Phone or write the nearest LINDE office.

Here, risers on stainless steel castings are being powder-cut—a time saving of 30 per cent over the former methods.

Linde
Trade-Mark

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

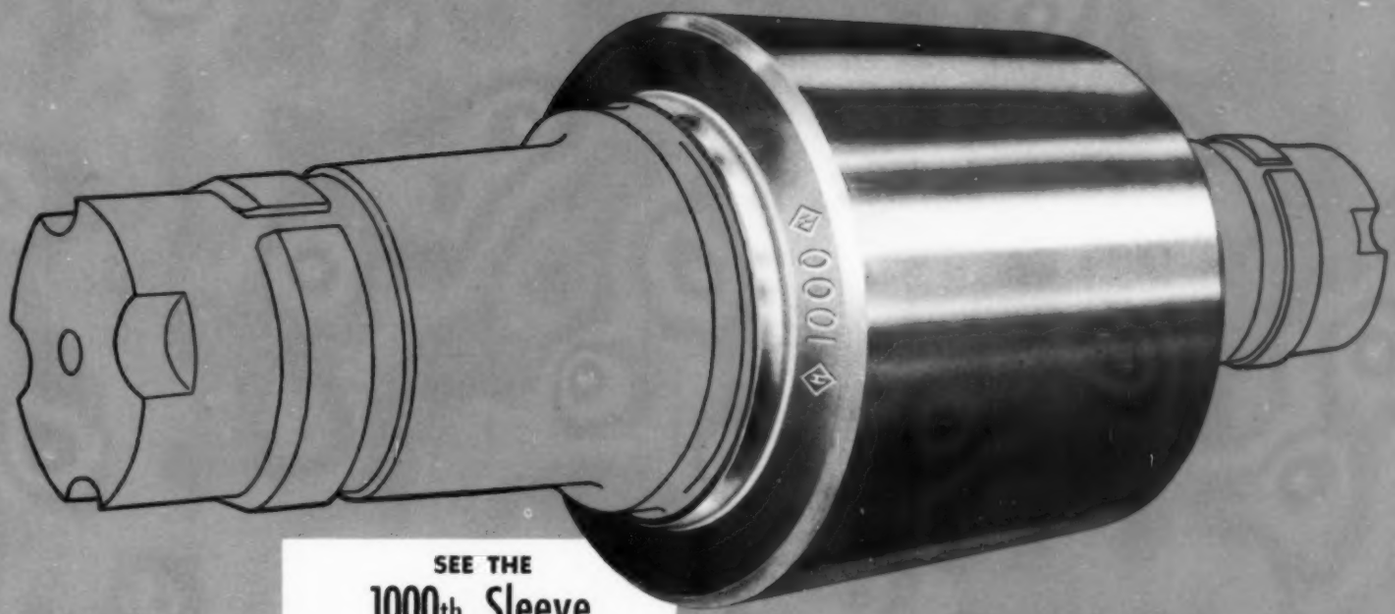
30 East 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

The word "Linde" is a registered trade-mark of The Linde Air Products Company

Presenting the 1000th back-up roll SLEEVE

forged by Heppenstall



SEE THE
1000th Sleeve
AT THE
Iron & Steel Exposition
Cleveland, Sept. 28 to Oct. 1

All the skill and experience gained during years of designing, making fine steels, and fabricating sleeves stands behind Sleeve No. 1000. We regard it as a milestone—and we have 999 good reasons to believe that it will roll up an impressive tonnage record, just as its predecessors did.

We're positive Sleeve No. 1000 is flawless, because accurate quality control through every step of manufacture has always been a strict routine at Heppenstall. Now, as a further check, the metal soundness of each sleeve is tested by the supersonic reflectoscope. Yes, we're proud of Sleeve No. 1000 and want you to see it—that's why we are displaying it at the Iron & Steel Exposition.

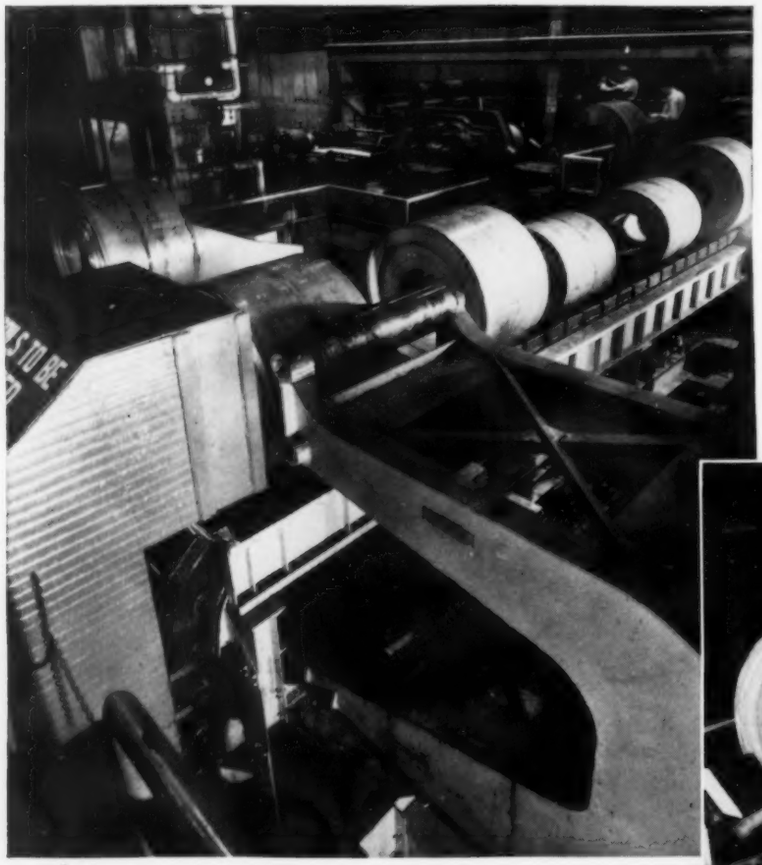
In every Heppenstall Sleeve, the density of the forged steel and the ease with which the forging can be grain refined during heat treatment produces working surfaces which are ideally suited to the job. These features, plus the longer service life obtained, have prompted strip mills to install Heppenstall Sleeves as *initial equipment*—in preference to solid cast rolls.

Heppenstall also produces forged arbors, and has every facility for sizing your worn cast rolls to form arbors . . . and for perfect shrink-fitting of sleeves to arbors.

Heppenstall Company, Pittsburgh 1, Pennsylvania

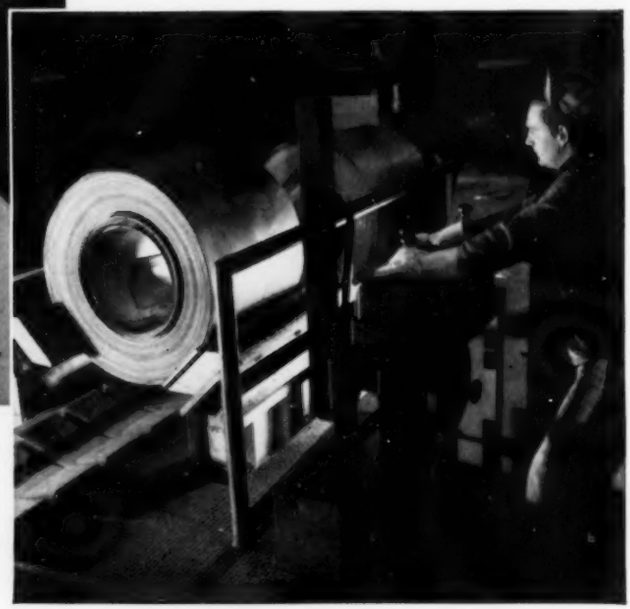
Heppenstall—*the most dependable name in forgings*

No Coil Edge Damage at Aliquippa



With LINK-BELT Coil Conveyors

Said to be the heaviest pallet type conveyors ever built for handling steel coils, the Link-Belt coil conveyors at the Aliquippa plant of Jones & Laughlin carry coils weighing up to 15 tons, on their sides.



▲ At delivery end, coils are again weighed, then rolled onto conveyor and carried to hydraulic push-off in foreground, which transfers them to flat-top storage conveyor.

➔ Link-Belt coil conveyor at weighing station, ahead of continuous pickling line.

Coils Ride on Side of New Type Conveyor

The bigger the coil, the greater the waste if edges are scuffed or coils telescope. The trend toward larger coils is matched by Link-Belt in developing the V-Top conveyor on which these heavy coils, resting on their sides, ride safely to and from the continuous pickling line.

Link-Belt coil conveyors protect while they transport. Ample bearing surfaces, rugged construction conforming to steel mill requirements, and advanced design, combine to provide safe handling at low operating costs.

A Link-Belt Engineer will be pleased to discuss your handling problems.

LINK-BELT COMPANY

Chicago 9, Pittsburgh 13, Cleveland 13, Detroit 4, Indianapolis 6, St. Louis 1, Kansas City 6, Mo., Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

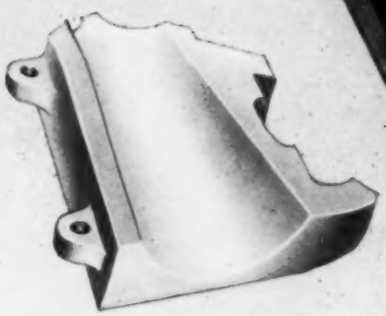
11,180

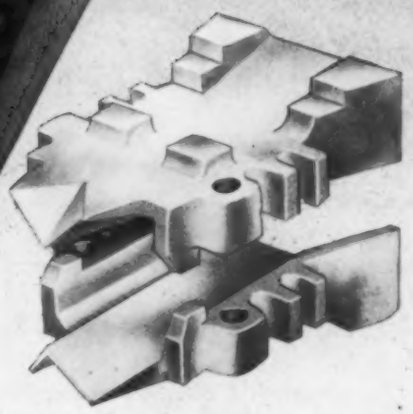
LINK-BELT
THE SYMBOL OF QUALITY
LINK-BELT
CONVEYORS
HANDLING EQUIPMENT . . . POWER TRANSMISSION MACHINERY

SEE OUR EXHIBIT - IRON AND STEEL EXPOSITION - CLEVELAND - SEPTEMBER 28 THROUGH OCTOBER 1.

TRANTINYL

GUIDES THE STEEL INDUSTRY





PRODUCTION · QUALITY · YIELD

YOUNGSTOWN ALLOY CASTING CORPORATION

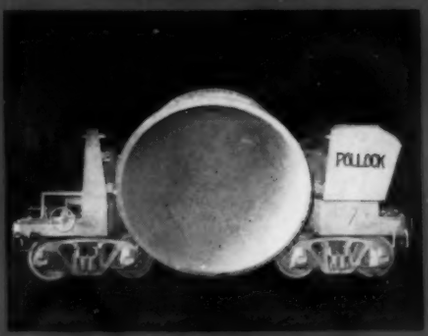
YOUNGSTOWN 1, OHIO

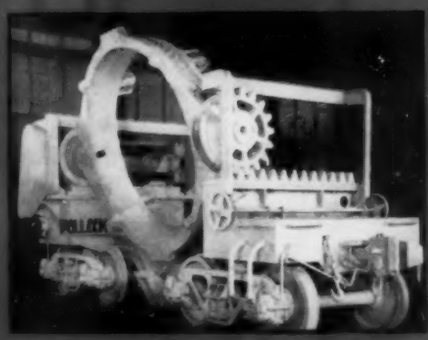
modern cinder cars for modern steel plants

speed up your cinder handling operations

Pollock's modern cinder car design is the result of 50 years' experience in building this type of car. Made for air, steam, or electric operation, Pollock cinder cars are sturdily built of all-rolled welded steel construction. Operating equipment can be arranged to dump from either side, and trucks have A. A. R. standard wheels, axles, bearing brasses and springs. In addition, special end-thrust bearings can be provided where standard A. A. R. bearings wear too fast, or roller bearings of your choice can be provided. Cars can be equipped with K brakes or AB brakes. Cars can be built to handle any size pot up to railroad clearances available or to carry two pots if desired.

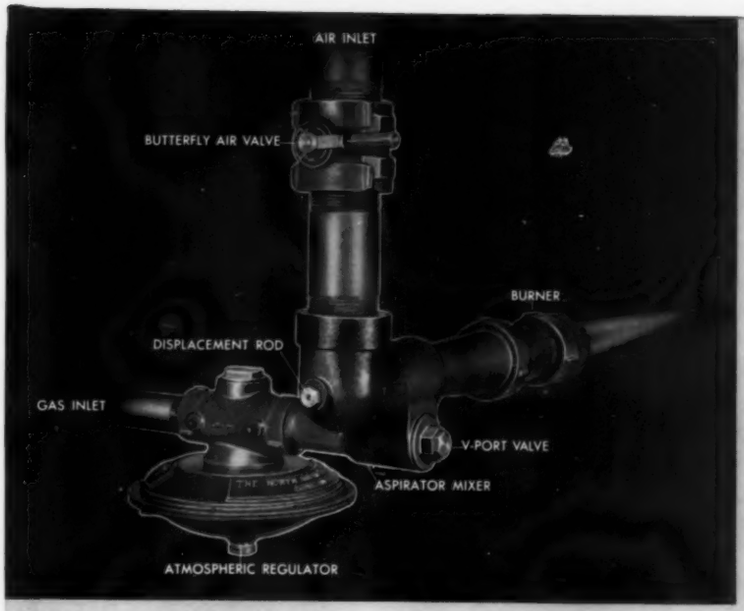
Pollock cinder cars are made in various sizes, designs and capacities, and are widely used throughout the iron and steel industries. Let Pollock advise you as to the type best suited to your individual plant requirements. Write or call today for complete information.





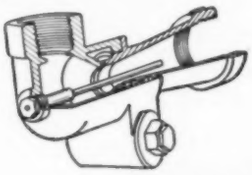
THE WILLIAM B. POLLOCK COMPANY **POLLOCK** YOUNGSTOWN, OHIO

STEEL PLATE CONSTRUCTION • ENGINEERS • FABRICATORS • ERECTORS • BLAST FURNACES • HOT METAL CARS AND LADLES
CINDER AND SLAG CARS • INGOT MOULD CARS • CHARGING BOX CARS • WELDED OPEN HEARTH LADLES • WELDED STEEL PRODUCTS



NORTH AMERICAN *Aspirator Mixers*

UNEQUALLED *for* EFFICIENCY *or* ADAPTABILITY



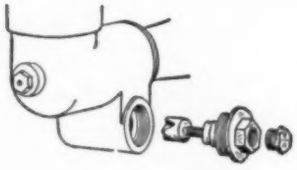
EFFICIENT DESIGN

and precision manufacture of the internal parts enable the air flowing through the mixer to create enough suction to draw the gas into the mixer and deliver an intimate mixture of gas and air to the burners at high pressure.

INTERCHANGEABLE ROD

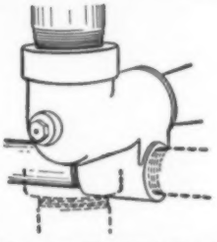
permits changing the orifices to conform to the particular conditions found in the field and still provide the optimum mixture pressure and suction ratios for the job at hand. Standard rods of varying diameters are interchanged without breaking any piping. Easily adjustable for greater mixture pressure with lower suction, or lower mixture pressure with higher suction.

NORTH AMERICAN *for* COMBUSTION



SENSITIVE V-PORT ADJUSTMENT

provides positive setting of the gas-air ratio on any gas from 500 to 3200 Btu per cubic foot (20 complete turns of the valve are required to go from fully open to fully closed).



COMPACT, FLEXIBLE DESIGN

makes the North American Aspirator Mixer easy to install on any industrial furnace or oven. Over-all length not excessive.

THE NORTH AMERICAN MANUFACTURING COMPANY

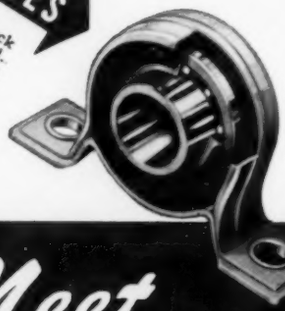
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL

BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES

CLEVELAND 5, OHIO

TYPE SES

Ball bearing unit pillow block—assembled and lubricated. Rubber-mounted for quiet operation.



TYPE SUS

Self-aligning ball bearing unit pillow block—with ring seals to exclude dirt.

Meet THE SKF FAMILY OF PILLOW BLOCKS

TYPE SUA

Self-aligning ball bearing unit pillow block, adapter mounting. Furnished assembled and lubricated ready for easy installation. Ring seals exclude dirt. TYPE SUAR—Same pillow block equipped with spherical roller bearings.

TYPE SAF

Supplied with either self-aligning ball bearings or spherical roller bearings with adapter mounting. Bearings protected with SKF Triple-Seal rings. TYPE SA—Same unit using felt seals.

How often are you confronted with the question, "Shall we use a ball or roller bearing pillow block?" The SKF line can handle ALL jobs—the BIG jobs, the *little* jobs, the in-between jobs—with pillow blocks equipped with either ball or roller bearings to handle the known loads, speeds and operating conditions of *your* job. Authorized SKF Distributors carry pillow blocks in stock. Send for Catalog 280, second edition. 6452

SKF INDUSTRIES, INC., PHILA. 32, PA.

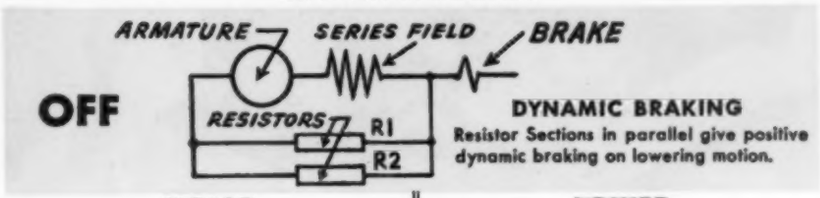
TYPE SDAF

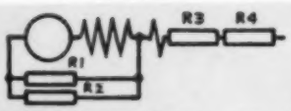
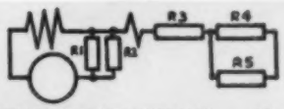
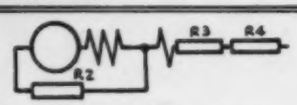
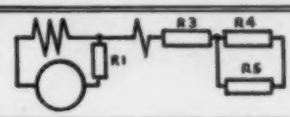
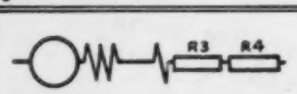
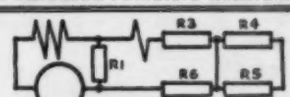
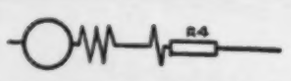
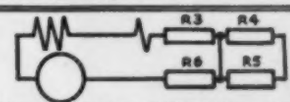
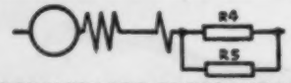
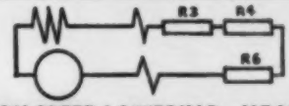
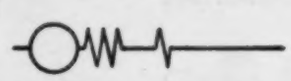
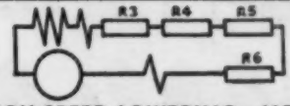
Exceptionally heavy and rugged pillow block with self-aligning spherical roller bearings for severe loads. Equipped with SKF Triple-Seal rings.

SKF PILLOW BLOCKS

New DYNAMIC LOWERING NETWORK SYSTEM FOR HOIST CONTROL

OPERATION



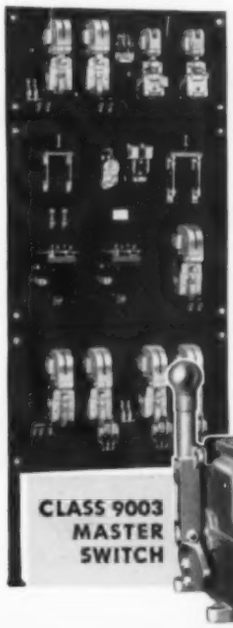
HOIST	LOWER
1 H  SLACK CABLE POINT . . . Double Armature Shunt	 1 L LOW SPEED SPOTTING . . . Heavy Field, Regenerative Action
2 H  LOW SPEED-LIGHT HOOK . . . Single Armature Shunt	 2 L INTERMEDIATE SPEED SPOTTING . . . Increased Armature Resistance
3 H  INTERMEDIATE SPEED-LIGHT LOAD . . . Series Resistor	 3 L LOW SPEED LOWERING . . . Network, Bridge Connection
4 H  LOW SPEED-HEAVY LOAD . . . Series Resistor	 4 L FULL SPEED LOWERING—FULL LOAD . . . Network, Potentiometer Connection
5 H  INTERMEDIATE SPEED-HEAVY LOAD . . . Series Resistor, Parallel Connection	 5 L HIGH SPEED LOWERING—HEAVY LOAD . . . Full Field
6 H  FULL SPEED . . . Across-the-line	 6 L HIGH SPEED LOWERING—LIGHT LOAD . . . Field Weakening

Safer. Two spring closed contactors and resistor sections in parallel insure positive dynamic braking on lowering motion.

More Control over hook. Double armature shunt makes slack cable and low speed—light hook points individually adjustable. Series relay provides for high speed lowering of heavy load with full field stability, and yet permits field weakening necessary for high speed lowering of light loads.

Reduced Maintenance. Network circuit is designed for low current peaks during motor acceleration. Maintenance is minimized on control contactors as well as on motor commutator and brushes. Only nine contactors are required for control system.

Less Space for resistors. Network system is designed for maximum use of resistor sections, and reserve capacity can be provided within reasonable dimensions.



Class 7954 Dynamic Lowering Hoist Control Panel
Only nine contactors are needed to give better hook control with the new network system.

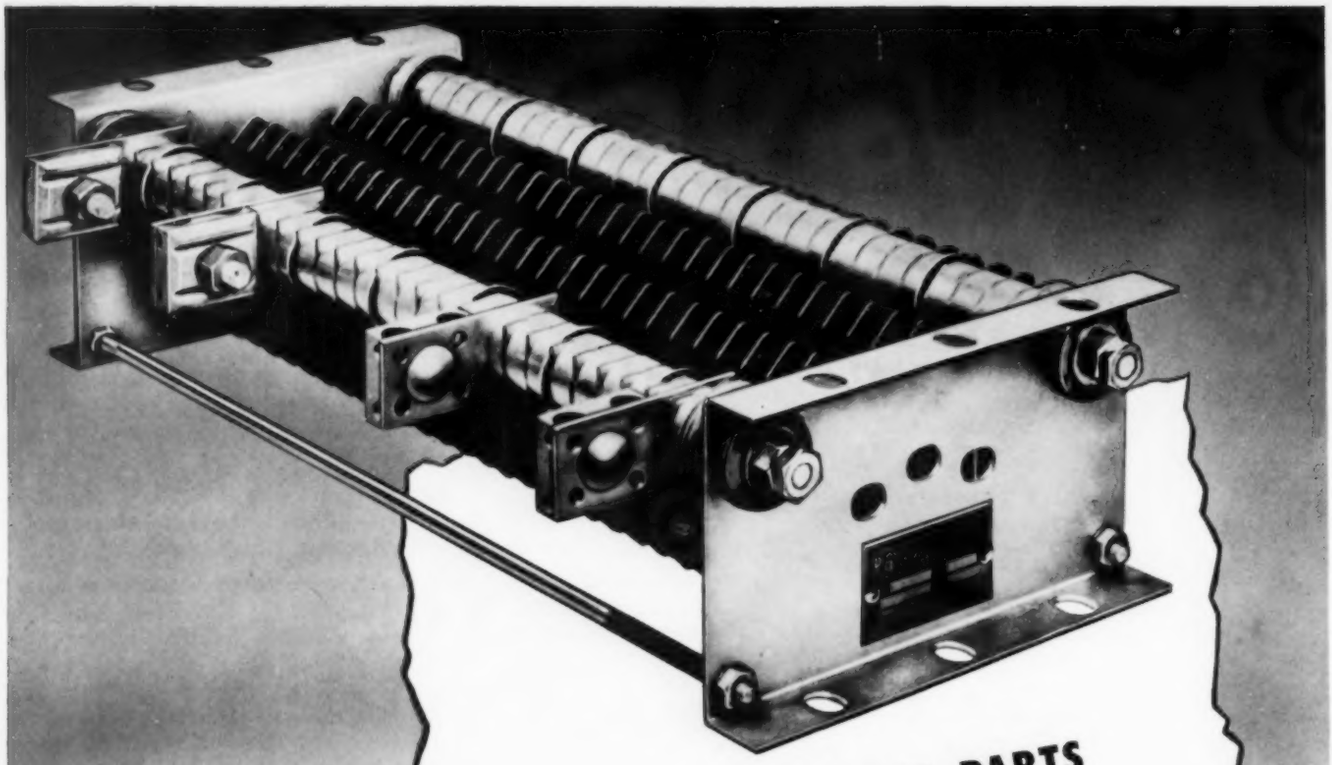
Write for descriptive Bulletin 7954. Square D Company, 4041 N. Richards Street, Milwaukee 12, Wis.

CLASS 9003 MASTER SWITCH

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S. A., MEXICO CITY, D. F.



REDUCE INVENTORIES OF MAINTENANCE PARTS

. . . with P-G *Steel Grid Resistors* . . .

Post-Glover Standard Resistor Units, of identical dimensions, are produced in a wide variety of resistance values and capacities.

In combination, they give complete resistor values for practically any motor control desired.

Because comparatively few types are necessary in the supply room, maintenance repairs are made with the utmost speed and a minimum investment.

A P-G sales engineer will be glad to explain . . . in detail . . . how you can save with the Nonbreakable Steel Grid Resistor.

ALL STEEL CONSTRUCTION
MICA INSULATION
RUGGED TERMINALS
PROVISION FOR EXPANSION
ADEQUATE VENTILATION
UNAFFECTED BY VIBRATION
MOISTURE RESISTANT
CORROSION PROTECTED

Write for Bulletin No. 500

P-G

The Nonbreakable Steel Grid Resistor

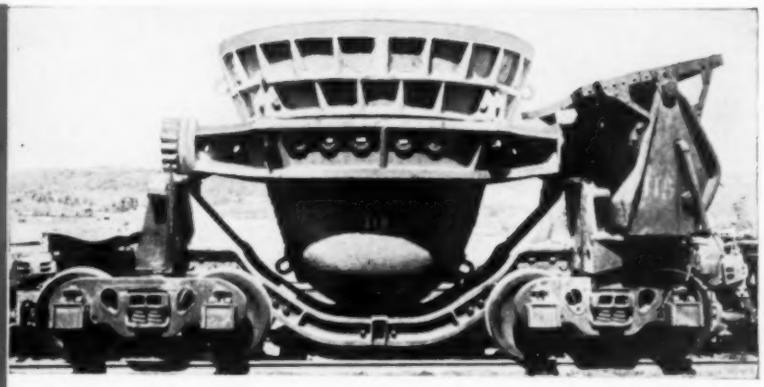
THE POST-GLOVER ELECTRIC COMPANY

•ESTABLISHED 1892•

221 WEST THIRD STREET, CINCINNATI 2, OHIO

TREADWELL

CINDER CARS



for

BLAST FURNACE

OPEN HEARTH and

ELECTRIC FURNACE SERVICE

SINGLE,

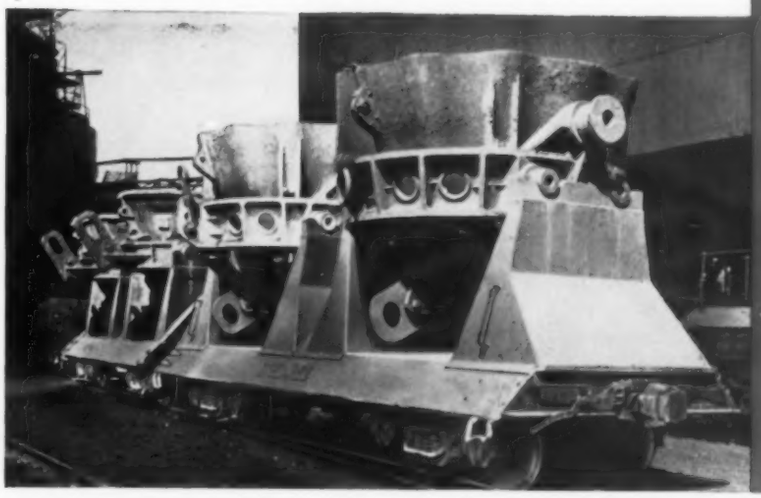
TWIN and

MULTIPLE POT DESIGN

Operated by

AIR, STEAM,

MOTOR or CRANE



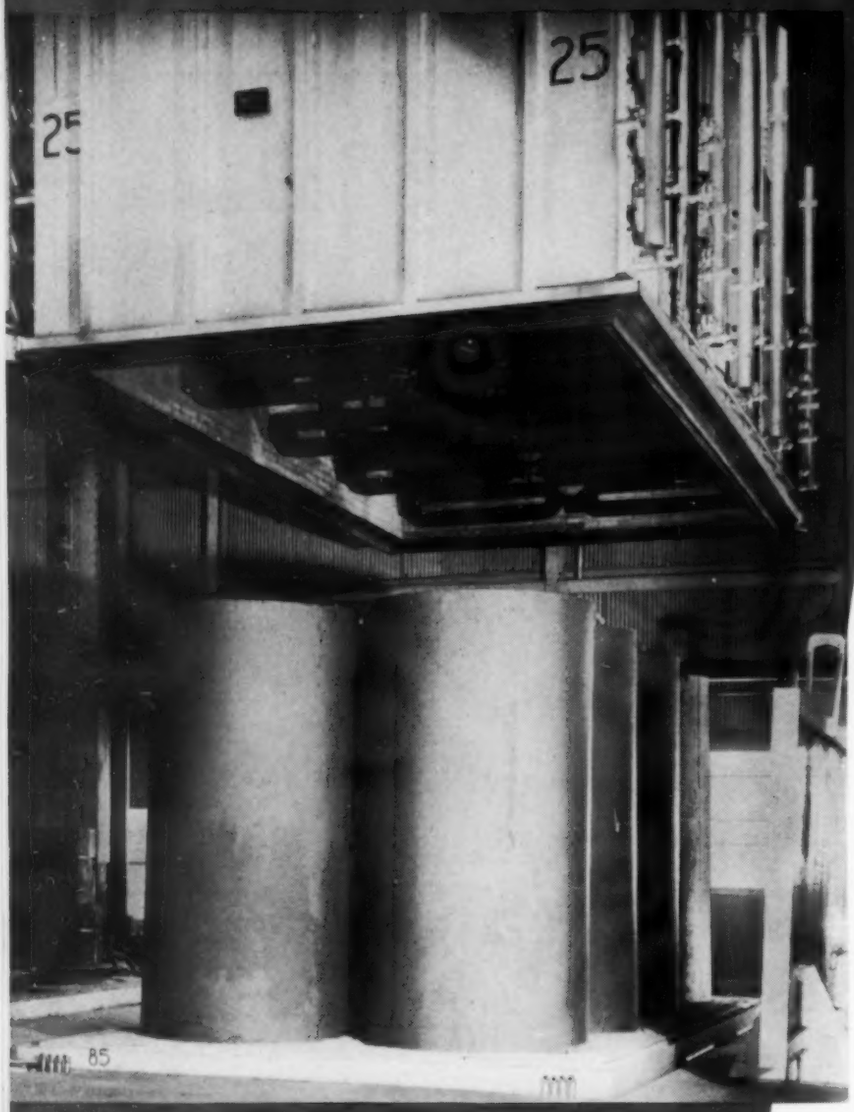
M. H. TREADWELL CO., INC.

208 S. LA SALLE ST.
CHICAGO 4, ILL.
CEntral 6-6784

140 CEDAR STREET
NEW YORK 6, N. Y.
WOrth 4-3344

1217 FARMERS BANK BLDG.
PITTSBURGH 22, A.
ATlantic 2883

HEAD, WRIGHTSON AND CO., LTD., Thornaby on Tees, England



Leadership at work!

ONE of **16 COIL FURNACES** installed in a large Midwestern plant—

plus

10 FLAT SHEET FURNACES installed at the same time

SWINDELL-DRESSLER

RECIRCULATING RADIANT TUBE

In this large Swindell-Dressler installation, each 40-tube furnace is capable of annealing eight stacks per base of sheet steel in 72" O.D. diameter coils, stacked 150" high —aggregating 600 tons of metal per heat.

Let a Swindell-Dressler Engineer consult with you regarding your particular furnace requirements—on any scale, anywhere.

SHEET ANNEALING FURNACES

SWINDELL-DRESSLER Corporation

DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH 30, PA.

Volume
COLD DRAWING PRODUCTION
means
Vaughn
COLD DRAWING MACHINERY

High-level output of cold drawn products is maintained consistently by Vaughn Cold Drawing Machinery — engineered and built to stand the gaff under constant production pressure. Check with us on the interesting reasons - why!

V

Quick on the Draw!"
VAUGHN MACHINERY
PROFITABLY USED BY LEADING PRODUCERS SINCE 1871

THE VAUGHN MACHINERY COMPANY, CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

POWER

where you need it...when you need it

with

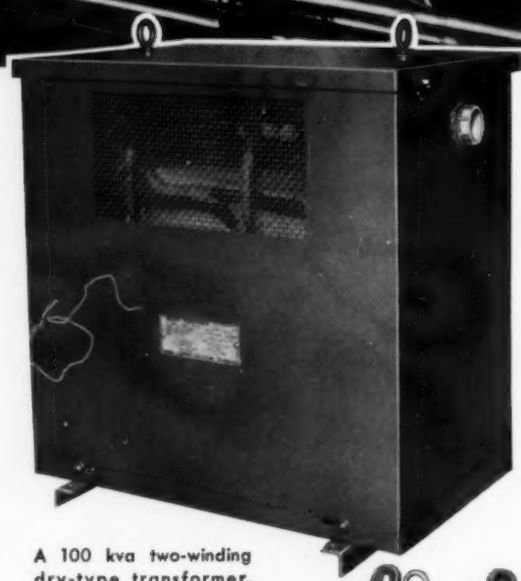
Wagner Dry-Type Transformers

Modern manufacturing and lighting methods impose many varied demands on the power circuits in your plant. The safest, most economical way to put power *where* you need it—*when* you need it is to install Wagner dry-type transformers.

No special vaults are required, even in locations where fire hazards are present—consequently, you have lower installation costs and lower insurance rates. Speedy, nationwide service facilities are available to users of Wagner Transformers.

Twenty-nine branch offices, located in principal cities and manned by trained field engineers, are at your service. Consult the nearest office on your next transformer problem. Bulletins TU-180 and TU-181 will give you complete information on the complete line of Wagner Power and Distribution Transformers.

Wagner Electric Corporation
6483 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.

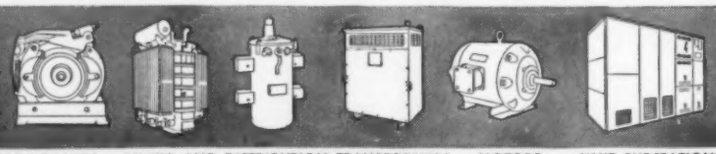


A 100 kva two-winding dry-type transformer, showing typical construction used in the larger units, which are designed for indoor service only.

Typical construction of two-winding dry-type transformers through 10 kva, and air-cooled autotransformers through 25 kva. These sizes can be installed indoors or outdoors.

Wagner Electric Corporation
EST. WE 1891

Consult Wagner Engineers on All Transformer Problems



BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

ELECTRICAL AND AUTOMOTIVE PRODUCTS

T48-2

GET THIS NEW

Bulletin

. . . IT'S FILLED WITH

FACTS YOU'LL WANT

ON **QUALITY HEATING**

Important Data on the
Urquhart Combustion Process
for Industrial Furnaces
HOW THE PROCESS FUNCTIONS
FORGE FURNACE APPLICATION
SOAKING PIT APPLICATION
URQUHART PROCESS CAN BE APPLIED TO YOUR PRESENT FURNACES WITH MINIMUM CHANGES

Just off the press—the most factual information available on the Urquhart Combustion Process—giving actual case histories and the things you'd like to know. Write today for your free copy.

STEEL PROCESSING COMPANY

FORT PITT BRIDGE WORKS SUBSIDIARY

PITTSBURGH, PA.

Save Money!

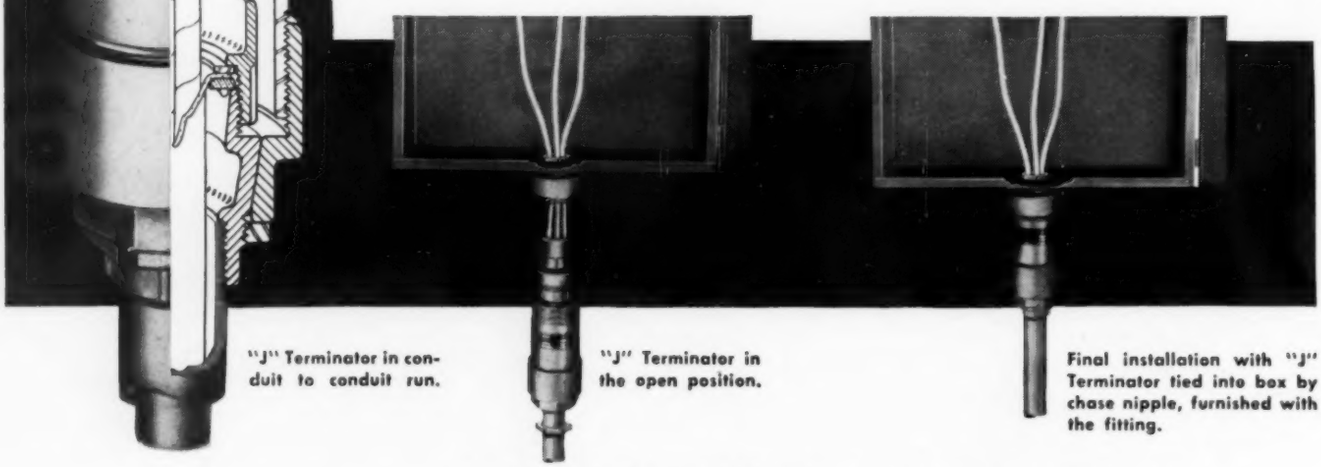
SEAL—TERMINATE—INSPECT

without disturbing other equipment

Use O.Z. "J" Terminators

The special collapsible design feature of O.Z. "J" Terminators saves time and effort in electrical installations . . . reduces maintenance costs. Here's how the "J" Terminator saves you money:

- **Efficiently seals and terminates conduits and cables outside cabinets.**
- **Permits subsequent inspections or current checks without circuit interruption by merely dropping sleeve.**
- **Serves as pulling and splicing chamber.**
- **Collapsible feature permits terminating conduit at enclosure, or terminating conduit and then continuing run.**



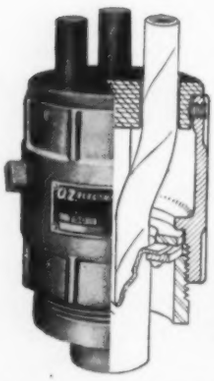
"J" Terminator in conduit to conduit run.

"J" Terminator in the open position.

Final installation with "J" Terminator tied into box by chase nipple, furnished with the fitting.

In addition to the "J", O.Z. makes a complete line of terminating potheads, compound bushings and sealing bushings for lead and rubber-covered, braided, and armored cables. With these designs, it is possible to meet all industrial requirements.

When special equipment is needed, our engineering department is prepared to cooperate with you. Write O.Z.'s Service Manager now, for a detailed catalog of electrical fittings.



TYPE "CLC" TERMINATING POTHEAD. A compact terminator designed for lead-covered cable. It seals the cable and grounds the lead sheath. Body of fitting screws directly on the conduit.

THEY'RE O.K. IF THEY'RE O.Z.

CONDUIT FITTINGS • CAST IRON BOXES • SOLDERLESS CONNECTORS
CABLE TERMINATORS • GROUNDING DEVICES • POWER CONNECTORS

O.Z. ELECTRICAL MANUFACTURING COMPANY

262 BOND STREET BROOKLYN 2, N. Y. 4286

For 120 tons of Refractory in ONE PIECE, use cast-in-place Refractory Concrete

Electric-arc furnace for phosphate reduction. Refractory Concrete dome measures 15 ft. by 32 ft. by 12½ ft. high, inside dimensions. One of several furnaces designed and built by Division of Chemical Engineering, Tennessee Valley Authority, Wilson Dam, Ala.

Construction of this TVA furnace shows how you can build a big refractory unit without joints—how you can get the exact shape needed for most efficient operation, and accurately locate openings in awkward positions.

Notice how the charging holes and peep holes are *formed into* the furnace dome. The round cores can be set at any angle. The holes are true rounds, made without cutting or fitting, and without the bother of providing special shapes.

After the forms were built, Refractory Concrete, made with LUMNITE and crushed firebrick, was placed in the same way as ordinary concrete is placed in a foundation. The result is a jointless dome, designed like a catenary arch, varying in thickness from 13½ in. to 30 in., with 3 electrode openings and 18 holes for charging and inspection.

The ADAPTABILITY of Refractory Concrete made possible this 120-ton unit. You, too, can save effort, time and money by using adaptable Refractory Concrete—whether you have to build a big furnace or make a small burner-block.

Formwork ready for placing Refractory Concrete

For free booklet with complete information on mixes and methods, write: LUMNITE DIVISION, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Bldg., New York 17, New York.

LUMNITE A UNIVERSAL ATLAS PRODUCT **FOR REFRACTORY CONCRETE**

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—September to June—ABC Network*

DATE LINE DIARY...

August 1

▲ Mr. R. S. Sage, Manager of General Electric's Mining Industries Division predicted that the mining industry will require much greater use of electric power than ever before. Power consumption has increased 40 per cent in the last ten years requiring some 10 billion kilo-watthours of energy annually. The increase in mechanized coal mining as well as the greater processing which will be required in the future on iron ores will add appreciably to this power load in the future.

August 2

▲ The Allegheny Ludlum Steel Corporation announced today the first general increase in stainless steel prices in over two and one-half years. All stainless steel products are increased ten per cent. The price increase was due to the increase in the price of raw materials, as nickel which has gone up $210.00 per ton, and there has also been an increase in labor costs.

▲ Benjamin F. Fairless, president of the United States Steel Corporation proposed to eastern railroads reduction in freight rates amounting to approximately 40 per cent on various iron and steel articles moving from the Pittsburgh district to the New York City and Detroit areas.

▲ The operating rate of steel companies having 94 per cent of the steel capacity will be 94.2 per cent for the week beginning August 2, equivalent to 1,697,900 tons of steel ingots and castings compared with 1,678,100 tons one week ago.

August 3

▲ Net sales of the Westinghouse Electric Corporation during the first six months of 1948 hit a new record high of $424,456,102. This is a seven per cent increase over the previous high during the same period of 1947. Net earnings for the first six months of 1948 amounted to 5.9 cents from each dollar of net sales.

August 4

▲ Shipment of steel pipes and tube during the first six months of 1948 totaled 3,302,748 tons or an increase of 10.7 per cent over the record shipments of the first half of 1947. Pipe and tube shipments in this period were 10.2 per cent of the total steel shipments.

August 5

▲ H. J. Kaiser today announced an increase in steel prices averaging approximately $30.00 per ton effective August 15. This increase according to the announcement is necessary in order to pay off a Government debt and then set up the capital structure of the company so that it would be on a competitive basis with other concerns.

▲ The Westinghouse Electric Corporation announced that it would purchase 500 shares of stock in the Baldwin Locomotive Works at $15.11 per share, thereby giving Westinghouse a 21 per cent interest in Baldwin and also an indirect interest in the Midvale Company which is partially owned by Baldwin.

▲ Of the 1,200,000 tons of German scrap, 440,000 tons have been earmarked for United States buyers.

August 6

▲ Domestic freight car deliveries during July totaled 8706, leaving a backlog on August 1 of 125,093 cars.

▲ Shipments of finished steel products for the first six months of 1948 with a tonnage of 32,250,000 exceeded any other six month period.

▲ Carnegie-Illinois Steel Corporation announced today new mill prices of stainless steel products effective August 9, 1948 with an average increase of 9¼ per cent over previous prices. The American Steel and Wire Company announced a similar increase.

August 9

▲ The Allis-Chalmers Manufacturing Company announced net earnings for the first six months of 1948 of $6,306,658 or 2.28 per share after preferred dividends and provision for estimated income taxes.

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 94.9 per cent of capacity for the week beginning August 9. This will be equivalent to the 1,710,500 tons of steel ingots and castings compared to 1,697,900 one week ago.

August 12

▲ The Alan Wood Steel Company reported that earnings for the first six months of 1948 after all charges and taxes were $1,274,356 or equivalent to $2.27 per share.

August 13

▲ Wages and salaries paid by the iron and steel industry the first half of 1948 totaled $1,054,059,000 which is higher than any previous half year. This payroll went to an average of 627,300 workers per month. Total payroll for June was $179,483,000 paid to 633,600 employees with an hourly average earning rate of $1.569. The half year average rate of wage workers received was $1.562 per hour.

August 15

▲ Net railway operating income for 132 class 1 railroads was $124,979,063 for June, which is double the amount reported for June, 1947. The major portion of the increase is due to boosts in freight and passenger rates.

August 16

▲ The United Engineering and Foundry Company, reporting for the six month period ending June 30, announced a net income of $1,934,435, which is equal to $2.32 per common share after preferred dividends. This is an increase over the $1.69 per common share for the corresponding period of 1947.

▲ Steel will apparently be required for ship construction as the United States Navy is planning 16 new vessels, and the Maritime Commission is promoting plans to build 20 tankers.

▲ The operating rate of steel companies having 94 per cent of the steel capacity will be 95 per cent of capacity for the week beginning August 16, 1948. This is equivalent to 1,712,400 tons of steel ingots and castings compared to 1,710,500 tons one week ago.

August 19

▲ The National Steel Corporation declared today a dividend of $1.00 per share for the third quarter of 1948, payable to stockholders of record August 31, 1948.

August 20

▲ Plans have been announced by the Mellon National Bank and Trust Company and the United States Steel Corporation for the construction of a 40-story skyscraper at Fifth Avenue and Smith-

field Street, which will be used as offices by the two concerns.

▲ The Commerce Department appointed a new industry advisory committee to investigate the feasibility of a steel allocation program for the mining machinery industry. It also instructed its Steel Task Committee to consider another new voluntary allocation agreement to provide steel plates for ship builders.

▲ According to the Federal Reserve Board one family in four lived above its 1947 income. However, approximately ⅓ of the family units saved about $25,000,000,000.

August 23

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 94.9 per cent of capacity for the week beginning August 3, 1948. This is equivalent to 1,728,600 tons of steel ingots and castings compared with 1,712,400 tons one week ago.

August 24

▲ The Westinghouse Electric Corporation registered 900,000 shares of common stock for purchase by employees through a payroll deduction plan in which the stock will be offered to the employees at $3.00 below the average market price of the stock in the month in which payment of the stock is completed.

August 25

▲ One producer has estimated that raw material shortages will hit the industry in 1949 and that it may be necessary to curtail iron production because of lack of iron ore or coke.

▲ The estimated total bookings of fabricated structural steel for the month of July was 167,960 tons, or an increase of 3.4 per cent over the previous month. A preliminary estimate of July shipments gives a total of 135,584 tons. The backlog for the next four months only stands at 613,200 tons.

▲ The Alan Wood Steel Company filed with the Securities and Exchange Commission a registration covering 6,300,000 first mortgage sinking fund bonds due 1963. Proceeds will be used to complete the purchase and installation of a 30-inch hot rolled strip mill. It is estimated that the installation of the mill will cost $8,900,000. This includes the $1,200,000 purchase price and $7,700,000 for reconditioning, shipping and re-erecting the mill at the company's plant in Conshohocken. The mill is being purchased from Jones & Laughlin Steel Corporation and is now located at the Otis Works in Cleveland.

August 26

▲ The Senate Small Business Committee is undertaking a survey of the sales and distribution patterns of the major steel mills. A questionnaire to determine this information has already been prepared and a testing of this questionnaire has been taking place in Pittsburgh with the Carnegie-Illinois Steel Corporation as the guinea pig. Mills will be asked quantities of steel sold to various types of customers and the geographical location of the customers.

August 28

▲ According to a survey by Factory Management and Maintenance productivity increased 4.4 per cent in the year ending August 2, 1948. This is the second consecutive year in which productivity has increased. Report is based on replies of 610 companies representing more than 10 per cent of total employment in the manufacturing industries. However, wage increases of 9.7 per cent in the industry covered by the survey exceed the gains in productivity.

August 30

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 95.2 per cent of capacity for the week beginning August 30, 1948. This is equivalent to 1,716,000 tons of steel ingots and castings compared to 1,728,600 tons one week ago.

August 31

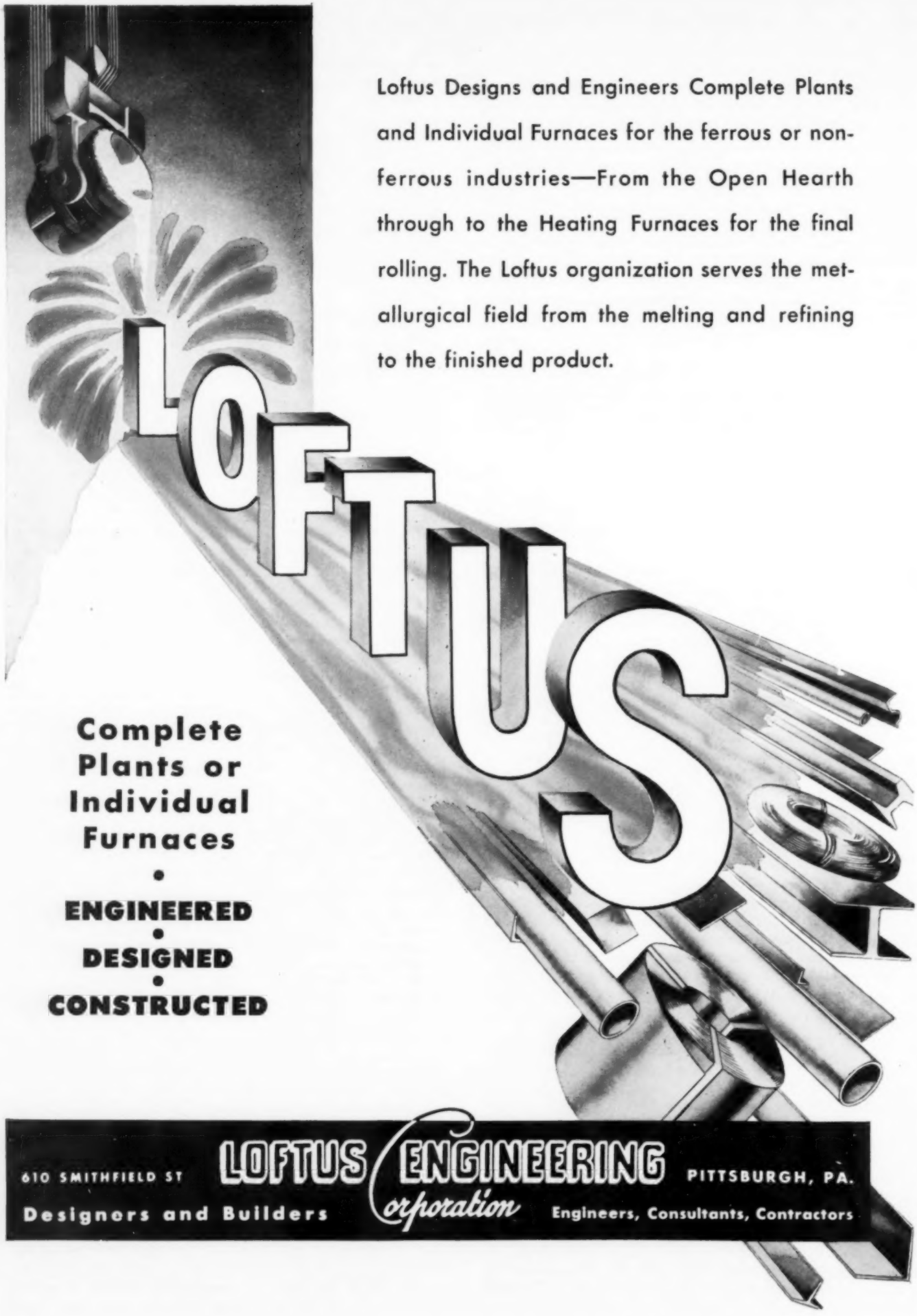
▲ The Youngstown Sheet and Tube Company has announced the construction of a new continuous butt weld pipe mill at Indiana Harbor, Indiana. This new mill will make pipe up to 4½ inch outside diameter and will have a capacity of 120,000 to 150,000 tons per year. Extensive changes will be required in the blooming mill and 10-inch skelp mill, and the capacity of the galvanizing plant must be doubled.

▲ Benjamin F. Fairless announced that the purchase of the assets of the Consolidated Western Steel Corporation by a new United States Steel Subsidiary of the same name will be closed today. No change in the present basis of operations is contemplated.

▲ It has just been announced that a sale of a substantial interest in the Butler Brothers, one of the large iron ore operators on the Mesabi Range has been made to a group composed of Armco Steel Corporation, Inland Steel Company, Wheeling Steel Corporation, and Hanna Coal & Ore Corporation. The Butler Brothers business will be continued under the same name and the same operating personnel, but Hanna will assume the supervision and management of the operations as agent for the interested parties.

▲ Production of railway freight cars in August passed the 10,000 mark and deliveries amounted to 10,362.

▲ The disposition of the blast furnace and coke ovens built by the Defense Plant Corporation and located at Republic Steel Corporation, Cleveland on the Cuyahoga River aroused a great deal of acrimonious debate in the past weeks. Republic's war time lease on this property expired September 1, 1947. On July 29, 1948 the War Assets Administration established a rental of $1,500,000 for the period of September 1, 1947 through August 31, 1948, and if the plant was not disposed of by the latter date the rent would be increased $2,500,000 a year. Republic in turn notified the War Assets Administration that it would close down the coke plant and blast furnace on this basis. Larson retracted his rent ultimatum and asked for counter proposals. President White wired Larson, "We are unwilling to proceed except upon basis satisfactory to us determined in advance." Mr. White's previous offer had been a tonnage rate with a minimum rental of $300,000 a year for the 450,000 ton blast furnace and the 382,000 coke plant. These were built originally at a cost of $28,000,000. Larson then offered the plant to the Kaiser-Frazer Corporation at a minimum rental of $800,000 a year and at a rate of $1.50 per ton of pig iron and $1.50 per ton of coke with an option to buy the plant now for $14,200,000. (Republic's best offer was $13,605,000.) Larson offered an option on a long term lease at $2.00 per ton of pig iron and $1.50 per ton of coke with an option to buy later at $15,200,000 and with a minimum rental of $800,000. Kaiser-Frazer accepted the offer. White then wired Larson, "We are amazed to note that the reported figure of $1,248,000 yearly rental (tonnage rental multiplied by capacity) which you are willing to accept from K-F is less than one-half of the $2,500,000 rental you were demanding from us . . . less than the rental we have heretofore offered." Republic estimated under its proposal the rental for the year would have been $1,275,000. As a result of this move the foundry industry who bought excess pig iron feared their supply of pig iron would be cut off, however Larson notified White to turn everything over to Kaiser-Frazer. After a hearing before the Senate Small Business Committee and House Expenditures Subcommittee a truce was agreed upon in which Republic Steel will operate the furnace until May 1, 1949 or until November 1, 1949 depending on when K-F wishes to take over the plant. Republic will pay K-F $1.40 per ton rental for the iron produced. Republic will supply its present customers with pig iron. Republic will also furnish K-F with 5000 tons of the monthly output. Kaiser-Frazer in the meantime took over the long term lease. Just what will happen is still not clear inasmuch as the lease is subject to approval by Attorney General Clark.



Loftus Designs and Engineers Complete Plants and Individual Furnaces for the ferrous or non-ferrous industries—From the Open Hearth through to the Heating Furnaces for the final rolling. The Loftus organization serves the metallurgical field from the melting and refining to the finished product.

Complete Plants or Individual Furnaces

• ENGINEERED • DESIGNED • CONSTRUCTED

610 SMITHFIELD ST **LOFTUS ENGINEERING** *corporation* PITTSBURGH, PA.

Designers and Builders — Engineers, Consultants, Contractors

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CO.

EHRET AND KINSEY
327 South LaSalle Street
CHICAGO 4, ILLINOIS
Representing
Cleveland Worm and Gear Co.
Worm Gearing
Farval Corporation
Farval Centralized Lube Systems
Lubrication Products Company
Stapax Journal Box Lubricators
Waldes Kohinoor, Inc.
Truarc Retaining Rings

CLEVELAND DISTRICT

HARRY J. FISHER AND ASSOCIATES
635 Ferguson Building
CLEVELAND 14, OHIO
Phone: MAin 0810
Representing:
Clark Controller Company
Lapp Insulator Company, Inc.
Pennsylvania Transformer Company
Branch Offices in Youngstown and Akron

DISPLAYED CLASSIFIED ADVERTISING
$8.00 PER INCH

PITTSBURGH DISTRICT

EDGAR M. MOORE & CO.
6964 Thomas Boulevard
PITTSBURGH 8, PA.
Transformers – Timers – Cable Take-up Reels
Resistors and Rheostats – Selenium Rectifiers
Pumpless Blow Torches — Molded Rubber Cable Connectors and Vulvanizers
Phone EMerson 8780

ROBERT T. JOHNSON
District Sales Representatives
NORTHERN ENGINEERING WORKS
E.O.T. Cranes – Electric Hoists – Air Hoists
THE HILL-ACME CO.
Alligator Shears – Portable Cranes – Special Machinery
Union Trust Building
PITTSBURGH, PA.
Phone: ATlantic 1535

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
Park Building PITTSBURGH, PA.

PENNELL ASSOCIATES
Complete Material Handling Systems
O. R. Heidenrich
Investment Building
PITTSBURGH 22, PA.
ATlantic 6734
ELWELL-PARKER ELECTRIC CO.
Electric Industrial Trucks
NUTTING TRUCK AND CASTER CO.
Warehouse and Floor Trucks
PHILLIPS MINE AND MILL SUPPLY CO.
Heavy Duty Trailers, Skids, Transfer Cars, Skid Dumps
WHITING CORPORATION
Electric Hoists
LIFT TRUCKS, INC.
Hand and Power Driven Lift Trucks
ELIZABETH IRON WORKS
Bridge Ramps for Car Loading
THE BUDA COMPANY
Buda Chore Boy

PITTSBURGH (Continued)

W. G. KERR CO., INC.
520 Oliver Building PITTSBURGH, PA.
Phone: ATlantic 4254
Representing:
FOOTE BROS. — Gears and Speed Reducers
REEVES — Variable Speed Drives
THOMAS — Flexible Couplings
SMITH — Telesmith Crushers
CULLEN-FRIESTEDT — Sheet Lifters – Welding Positioners – Track Cranes

PATTERSON-EMERSON-COMSTOCK, INC.
ENGINEERS AND CONSTRUCTORS
Specializing in Steel Mill Construction
313 E. Carson Street
Pittsburgh 19, Pa.
Phone: EVerglade 9800

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2217 OLIVER BUILDING PITTSBURGH 22, PA.
Cable Address "FOSTER" Pittsburgh

PRODUCTS

***Specify* SAUEREISEN**
ACIDPROOF CEMENTS—COMPOUNDS
FOR
Tanks, Sewers, Stacks, Floors
Technical cements for all purposes.
Send sketches or samples
Sauereisen Cements Company · Pittsburgh 15, Penna.

Don't Forget!
IRON AND STEEL EXPOSITION
Cleveland Public Auditorium
Cleveland, Ohio
September 28, 29, 30,
and October 1, 1948

THE ENGINEERING MART

CONSULTING ENGINEERS

LOYAL R. MILBURN
Consulting Electrical Engineer
Registered State of Michigan
16929 Lawton Avenue
Detroit 21, Michigan
Telephone: University 13874

MARTIN J. CONWAY

CONSULTING FUEL ENGINEER

GAP, PENNSYLVANIA Telephone: Gap 88

POSITIONS VACANT

ENGINEERS AND DRAFTSMEN
Mechanical, Electrical, Civil, Combustion

Integrated Steel Plant Experience Desirable. Long time foreign and domestic work. Best pay, pleasant conditions. Write or apply in person with complete record in strict confidence: The Armco International Corporation, Attention J. H. VanCampen, 58 E. Washington Street, Chicago 2, Illinois.

POSITIONS WANTED

STEEL MILL OPERATING SUPERVISOR

20 years experience practical engineering, mechanical, and operating background. Experienced in the erection of and placing in operation of the latest modern rolling mills. Recognized as an efficient organization and production man. Excellent knowledge of finishing operations and cost control. Qualified for operating, mechanical, or construction supervisory position. Experience and references furnished upon request. Personal interview desired. Reply Box 802, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pennsylvania.

WANTED!

Copies of "THE MODERN STRIP MILL" published by the AISE. If your copy is not being used why not sell it? For details write to IRON AND STEEL ENGINEER, Box 903, 1010 Empire Building, Pittsburgh 22, Pennsylvania.

News Supplement

(*Continued from page 179*)

J&L ANNOUNCES HOUSING FOR ALIQUIPPA AREA

▲ Jones and Laughlin Steel Corporation has announced that John W. Galbreath and Company of Columbus, Ohio, has undertaken a program designed to help relieve Pennsylvania's critical housing shortage in Aliquippa, Pennsylvania. The program will give the Aliquippa community 225 new homes immediately, and may ultimately provide 400 to 500 home units. The corporation has arranged for the sale of approximately 70 acres from the Cooper Farm Tract (west of Broadhead Road) to Aliquippa Homes, Incorporated.

Aliquippa Homes, Incorporated, expects to begin work almost immediately on several typical model homes, probably on Mill Street in Aliquippa (formerly called Green Garden Road). They plan to build a 5-room, 1-story, ranch-style home; a 6-room, 1-story unit; and a 2-bedroom, 1½-story home.

The homes are designed to sell at prices ranging from $8,000 to $10,500.

Seward Mott and Max Wehrly, land planning engineers of Washington, D. C., have prepared a complete site plan and will supervise the plotting of the houses on each individual lot. Mr. Mott is one of the foremost recognized authorities in the nation on the subject of land planning. The builders are particularly anxious to save all the trees on the tract and will locate the houses to take advantage of natural landscaping and view. Their planning is nearly completed and the engineering work and laying out of the streets and utilities will begin immediately.

Units will be processed through the FHA office at Pittsburgh. This will insure reasonable down payments and easy monthly payments over a period of years.

MAGNET LOADS ARE STEADILY INCREASING

▲ Loads on the larger 55 in. and 65 in. lifting magnets are steadily increasing. This is especially true to the handling of strip steel coils.

Downtown Company has brought

NEW BLAST FURNACES AT SOUTH CHICAGO

Two new blast furnaces are now in full operation at the South Chicago works of Carnegie-Illinois Steel Corporation, subsidiary of United States Steel. Numbered 11 and 12 — two in a string of six giant furnaces — they rank among the newest and largest in the world. The furnaces have a daily capacity exceeding 1500 tons and their combined yearly production will be 1,120,000 tons of iron.

out a frictionless suspension made of high alloy steel. This suspension is stronger than suspensions made of iron chain. It avoids the excessive wear due to friction. Each 55 in. suspension is tested to 85,000 lbs and each 65 in. suspension is tested to 115,000 lbs.

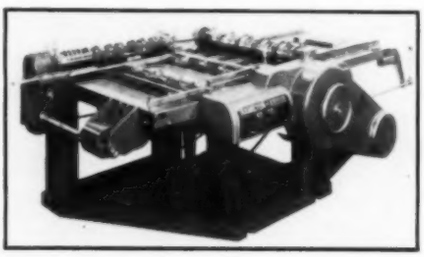
DUPLEX SLITTER CUTS 50 SHEETS PER MINUTE

▲A new duplex body blank slitter has been announced by Lima-Hamilton Corporation. Known as the Hamilton-Kruse No. 301, the 36-in. machine is designed for plain iron or tin sheets having a maximum thickness of approximately .017 in. Operating speed of the machine is 50 sheets a minute or slower, depending upon requirements.

Cutters supplied with the machines are of high-carbon, high-chrome forged steel. These cutters, according to tests reported by the company, give from 40 to 50 per cent more service between grindings than various other makes.

The slitter will trim and slit sheets up to 36 in. square into strips on the first unit, and then automatically trim and slit the strips into body blanks on the second. For cap stock and for blanking bodies of large size cans, the same basic machine, with a different feed arrangement, will trim sheets on the first unit, and then trim or trim and slit them on the second.

Sheets are fed from the first operation to the second on the same plane and are fully controlled by automatic hold-downs which guarantee perfect registry and minimum scrap. The slitter can be arranged for plain material or lithographed sheets, and can be hand-fed or operated in conjunction with an automatic sheet feeder. This last setup, the company said, requires no operator, but only a laborer to load the feeder.



Floor space occupied by the machine measures 132 in. by 90 in., front to back by right to left, including grinding attachment. Approximate net weight of the machine, including the grinding attachment, is 7,270 lb. The unit stands approximately 40 in. high, from floor to top of feed table.

SODIUM FLUORIDE IS NOT HEALTH HAZARD

▲A study made by the industrial hygiene division of the Public Health Service shows that the use of sodium fluoride during the pouring of rimmed steel in open hearth furnaces does not create a health hazard. In the course of its investigation of steel pouring operations in open hearth furnaces, however, the division found other conditions which cause physical discomfort to the workers.

The division undertook its study at the joint request of the United Steelworkers of America — CIO and the Republic Steel Corporation. A preliminary report of the investigation which was carried on in January of this year was presented to representatives of the Steelworkers and Republic on April 14 in Columbus, Ohio. Although the study was made in four plants belonging to the Republic Steel Corporation (Youngstown, Canton, Cleveland, and Warren, Ohio), it is believed that the findings can be applied to similar operations carried on by other steel producers.

The addition of sodium fluoride to molten steel at the time it is poured into tar-lined molds helps produce an unusually tough steel which is free from blow holes.

In the course of the study, medical, oral, and x-ray examinations were made of 350 men. A hundred of these had never been exposed to sodium fluoride and were used as a control group. In addition, 174 samples of air and dust taken from the working environment were analyzed.

Analysis of the air and dust samples revealed that workers are not exposed to hazardous concentrations of sodium fluoride or other fumes or dusts. It was found, however, that at the time the molds are lined with pitch and tar, and later when the molten metal is poured, the smoke produced is excessively irritating. Radiant heat produced by the molten steel was also termed excessive. The medical, oral, and x-ray examinations revealed no changes which could be attributed to the use of sodium fluoride. However, slight inflammation of the lining of the nose, mouth and throat was attributed to the irritating smoke.

Among other things, the industrial hygiene division recommended that the Republic Steel Corporation try to find a mold-coating material which will produce less irritating smoke. In the meantime, it was recommended that the corporation control mold-coating operations so that less smoke will be produced. Workers should also be better protected from the excessive radiant heat, the division said.

SECOND EXPERIMENTAL MINE TEST APPROVED

▲Approval of a contract between the Bureau of Mines and the Alabama Power Company for a second and larger cooperative experiment in underground coal gasification at Gorgas, Alabama, was announced recently.

The initial joint experiment last summer showed that gases produced by burning unmined coal offer a potential source of fuel for power and raw materials for synthetic liquid fuels. If proven feasible, underground gasification offers alluring possibilities for minimizing expensive mining and for utilizing coal veins difficult or uneconomic to mine.

Cost of the large-scale field test, including Bureau expenditures and those of the company which are reimbursable, is estimated at $411,000 for a one-year period. Under the contract, the company will provide engineering and operating services on an actual cost basis (without profit), and will contribute as a site for the experiment some 300 acres of Pratt seam coal averaging 40 inches in thickness.

Preliminary core drilling already is in progress to determine the composition of the ground overlying the coal, which ranges from 60 to 125 ft in depth. The next phases of the site-preparation job to be undertaken will be the drilling of five large-diameter holes to the coal bed and the driving of two parallel entries, 1,200 ft from the coal outcrop into the bed and a single butt entry for an additional 300 ft. Equipment will be installed simultaneously.

It is estimated that the site-preparation work would be completed

next fall. At that time interested persons will be invited to inspect the underground workings before the coal bed is fired for the first experimental run.

INSTRUMENT INSULATION USES NEW DEVELOPMENTS

▲ Numerous improvements in thermocouple extension wire have resulted from the use of thermoplastic insulation, such as polyvinyl chloride, another example of how instrument design engineers are taking advantage of recently developed and perfected materials.

The new insulation, according to Brown Instrument Company engineers, has brought about numerous advantages to the thermocouple user. These advantages, it is said, are partly due to the physical and chemical characteristics of the thermoplastic and partly due to the type of extension wire construction made possible by its adoption.

By using thermoplastic insulation as a replacement of rubber as a primary insulation it not only disposes of many of the faults common to rubber-insulated extension wire, but also adds several new advantages.

Thermocouple extension wire insulation is made of two layers, namely, the primary and the secondary insulation. With the conventional rubber type insulation formerly used, the primary insulation comprises rubber applied over a color-coded cotton wrap which covers each individual conductor (thickness $\frac{3}{64}$ of an in.). In contrast, color-coded thermoplastic insulation is applied directly over each individual conductor (thickness $\frac{1}{64}$ of an in.).

The secondary insulation for both types comprises a cotton braid, which is applied over both the conductors and is impregnated with a weatherproof saturant. The net result is that 14 B & S gage thermoplastic extension wire has overall dimensions of $\frac{5}{32}$ of an in. × $\frac{7}{32}$ of an in. against $\frac{3}{16}$ of an in. x $\frac{5}{16}$ of an in. for the rubber insulated wire, a considerable reduction in size.

With rubber insulated extension wire, the vividness of the color-coding deteriorates after continued use or as a result of discoloring by the weatherproof saturant, with the use of thermoplastic wire, a permanently vivid color-coding, unaffected by the saturant, is attained.

There are two broad advantages in thermoplastic insulation, first, because the size of the thermoplastic leadwire is reduced, more wires can be run through a given conduit, or a smaller conduit may be used for a given number of wires. Second, the vividness and permanency of thermoplastic insulation color-coding minimizes the possibility of incorrect installations and facilitates maintenance.

The performance of thermoplastic extension wire under adverse operating conditions is definitely better. From extensive tests covering such conditions, see the performance data in Table I.

In summary, these tests show that, where extension wire is exposed to chemical action, thermoplastic insulated wire will have a vastly longer service life than conventional natural rubber insulation. The tests also show the resistance of thermoplastic extension wire to sunlight, mildew, fungi, molds and weathering to be greatly superior to that of rubber insulated wire.

Temperature tests made to find the effect of adverse conditions on thermoplastic insulation are summarized in Table II.

From this table, it is concluded that thermoplastic insulation will retain its insulating and physical properties should it be accidentally subjected to a temperature considerably in excess of those recommended.

Combustion hazard: thermoplastic extension wire offers a negligible combustion hazard. The thermoplastic primary insulation and overall braid will char but will not convey flame. On the other hand, with rubber insulation both the primary insulation and the insulated conductors, plus the overall braid of rubber insulation, will support combustion and convey flame regardless of the flame retardent saturant on the outside of the overall braid.

Maintenance: three principal factors facilitate the maintenance of thermocouple extension wire installations, namely: permanency of insulation, permanency of color-coding, and replaceability. As previously stated,

TABLE I — RESISTANCE TO AMBIENT CONDITIONS

Condition	Thermoplastic insulated wire	Natural rubber insulated wire
Exposure to mythl or ethyl alcohol	Not affected	Deteriorates
Exposure to gasoline, oils, and greases	Not affected	Swells and softens
Exposure to hydrogen sulfide	Not affected	Softens
Exposure to oxygen	Not affected	Deteriorates
Exposure to ozone	Not affected	Loses strength rapidly
Growth of fungi, molds and mildews	Primary insulation will not support growth even under warm and moist conditions	Primary insulation, cotton wrap between primary insulation and conductors will support growth under warm and moist conditions
Aging	No deterioration	Deteriorates with age due to progressive oxidation of primary insulation.
Oxidation	Virtually unaffected	Oxidation accelerated by elevated temperatures.
Exposure to sunlight and weathering	Unaffected	Deteriorate over a long period

TABLE II

RESISTANCE TO TEMPERATURE

Condition	Thermoplastic insulated wire
Generally recommended upper temperature limit	60 C (140 F)
Exposure at 250 F	Does not destroy insulating or physical properties
Exposure at 300 F	Chars insulation
Exposure at —30 F	Does not affect primary insulation adversely. Flexibility is retained.

The Same Conditions That Make Drinks Drip Cause Conduit Sweating and Wire Failures

Use ROCKBESTOS A.V.C. in Conduit Hot-Spots

——— it's the Cable that RESISTS CONDENSATION

Permanent insulation of impregnated asbestos and high-dielectric varnished cambric, covered with tough impregnated asbestos yarn braid—means, among other things, that it resists moisture.

Every conduit run exposed to high temperatures collects condensation some time or other.

It's a tough combination that does a fast job of ruining ordinary wire and cable. Moisture seeps through cracks in dried out, heat-baked insulation causing grounds, short circuits and expensive re-wiring projects.

But millions of feet of Rockbestos A.V.C. wires and cables in miles of heat-exposed conduit are operating dependably under just such severe conditions. Their impregnated asbestos insulation and braid won't bake out or crack to admit moisture . . . they keep heat away from the varnished cambric . . . and they are highly resistant to corrosive fumes, flame, grease and oil.

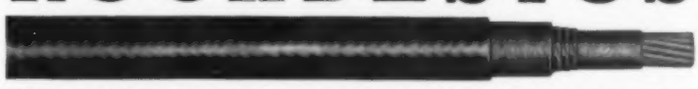
WRITE TODAY—for your copy of the new No. 10-F catalog, sectioned for easy reference to permanently insulated Power and Control Cables; Apparatus Wires and Cables; Lighting, Switchboard, Appliance, Fixture, Electronic and Magnet Wires.

ROCKBESTOS PRODUCTS CORPORATION

643 Nicoll St., New Haven 4, Conn.

NEW YORK CLEVELAND DETROIT CHICAGO
PITTSBURGH ST. LOUIS LOS ANGELES OAKLAND, CALIF.

ROCKBESTOS



THE WIRE WITH PERMANENT INSULATION

both the permanency of the insulation and its color-coding is superior in the case of thermoplastic insulation.

Thermoplastic wire is more easily replaced under adverse conditions.

Rubber insulation of wire, inside a conduit, if subjected to destructively high temperatures, becomes gummy, penetrates through the outer braid, and sticks to the other wires in the conduit, making it extremely difficult and often impossible to remove the old wire and install new, necessitating the installation of new conduit. Under the same conditions, thermoplastic insulated wire hardens and will crumble when disturbed. It is possible, therefore, to remove it from the conduit and replace it.

From the standpoint of maintenance, the thermoplastic type is superior because of its longer life, ease of replacement and convenience of repair.

BELT CONVEYOR USES CATENARY SWAY BRACES

▲ An unusual belt conveyor which travels two-thirds of its route over a suspension bridge inclined at a 19-degree angle, is now operating at the new cleaning plant of the United States Coal and Coke Company, a subsidiary of United States Steel Corporation.

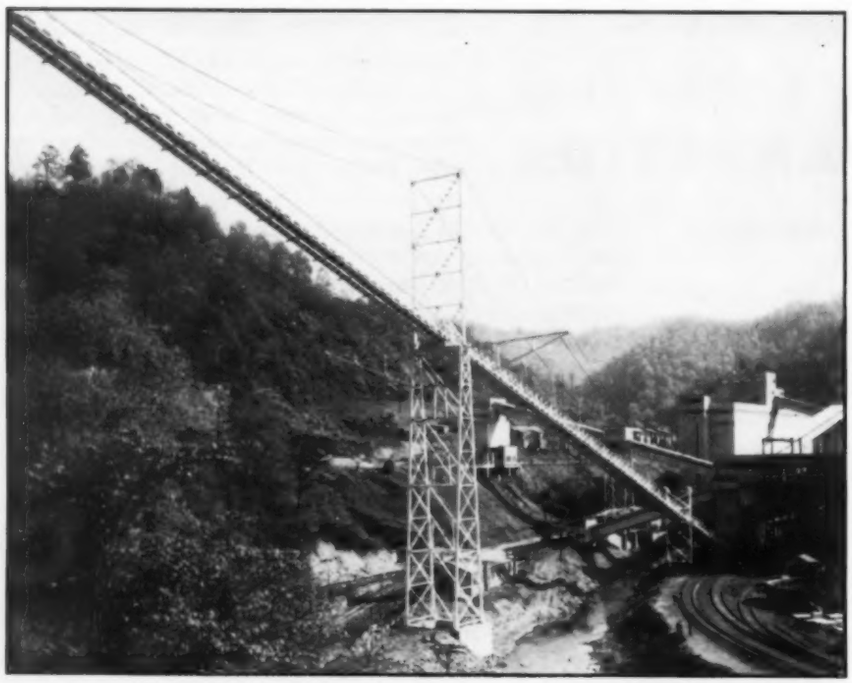
The belt was designed and built by Goodyear Tire and Rubber Company, Akron, Ohio, to carry refuse from a central coal cleaning plant in a valley to a spoil pile over a hill 1500 ft away. The 30-in. wide steel cable belt spans a deep gorge via the suspension bridge, which at one point is over 300 ft above ground.

An engineering feature of the bridge is the use of catenary sway braces attached to outriggers at the main supporting towers to stabilize the structure against side sway in high winds and prevent spillage from the belt.

The belt system is weather-protected by a corrugated metal hood. More than one million lineal feet of finely stranded steel cables, laid side by side in the belt's core, provide the strength member of the carrier. The belt was designed especially for this spectacular operation.

When operating at capacity, the belt will transport hourly 350 tons of shale, rock, slate and other coal-cleaning spoil, discharging 486 ft above the loading point. Built in three sections and vulcanized on the job, the endless belt makes a 3,000-ft round trip. Belt speed is 400 fpm.

Two-thirds of the route of this belt conveyor is at a 19 degree angle.



CALCULATOR FOR ILLUMINATION WORKS

▲ A pocket-size "Calcu-light-or" approximately 4 in. by 8½ in. for rapid illumination calculations has recently been developed by Westinghouse Electric Corporation. Of slide-rule design, the Calcu-light-or includes all of the technical information necessary to make illumination calculations either by the lumen or point-by-point methods. No regular slide rule is required with its use nor are any additional tables or charts needed for lumen-method calculations. A distribution curve is required for point-by-point calculations.

The calculator is available at the price of one dollar from Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

AUTOMATIC OPENS SERVICE DEPARTMENT

▲ Opening of their new service department for Automatic Transportation Company electric industrial trucks and transporter motorized hand trucks has been announced by Lindsley and Voss, Chicago area distributors for Automatic. To expand their facilities for maintenance and repair services, Lindsley and Voss recently acquired the Austin Industrial Truck Sales and Service Company, Inc., located at 221 West Lake Street, Oak Park, Illinois.

Services provided by Lindsley and Voss' industrial truck technicians will cover everything from routing check-ups and minor repairs to complete overhauling for any Automatic Transportation Company unit.

Units to be repaired will be picked up at the plant by Lindsley and Voss' own truck and returned to the factory ready to use. An on-the-spot emergency repair service also will be available.

The new department is the latest step by the fast-growing sales firm in adapting automotive techniques to industrial trucks. Recently, Lindsley and Voss opened their new Chicago headquarters at 948 South Michigan Avenue, where automatic fork trucks and transporter motorized hand trucks are displayed.

INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Company 1
Alliance Machine Company 6
Allis-Chalmers Manufacturing Company 142, 143
Aluminum Company of America 155
American Chemical Paint Company 172

B

Bailey Company, Wm. M. 170
Baker Industrial Truck Division of The Baker-Raulang Company 203
Bantam Bearings Division of The Torrington Company 202
Bedford Foundry and Machine Company 194
Bliss Company, E. W. 146, 147
Bloom Engineering Company 166
Bonnot Company 5
Brosius Company, Inc., Edgar E. 11
Buffalo Forge Company 157

C

Clark Controller Company 159
Cleveland Crane and Engineering Company 30
Clipper Manufacturing Company, The 185
Continental Foundry and Machine Company 169
Cutler-Hammer, Inc. ..... Cover 2

D

Deltabeston Division, General Electric Company 161
Delta-Star Electric Company 140
Dixon Crucible Company, Joseph 178
Documentation & Licenses, Paris, France 34
Dollinger Corporation 198
Downtown Company 192
Dravo Corporation 191
Drever Company, The 34

E

Eastern Pipe Maintenance Company 191
Electric Controller and Manufacturing Company 8
Electric Service Manufacturing Company 199

F

Falcon Bronze Company 191
Farrel-Birmingham Company, Inc. 24
Farval Corporation ..... Cover 3
Flinn & Dreffein Engineering Company 34
Furnace Engineers, Inc. 25

G

General Electric Company ..... Cover 4, 28, 29
Gleason & Company, Inc., J. L. 175

H

Hallden Machine Company, The 34
Hays Corporation, The 173
Heil Process Equipment Corporation 193
Heppenstall Company 205
Heyl & Patterson, Inc. 2
Holophane Company, Inc. 10
Hunt and Son, Inc., C. B. 158
Hyatt Bearings Division, General Motors Corporation 139
Hydropress, Inc. 3

I

Ingersoll-Rand Company 26
International Graphite and Electrode Corporation 196
International Nickel Company 200
I-T-E Circuit Breaker Company 27

J

Johns-Manville Corporation 197

K

Kling Brothers Engineering Works 188
Koppers Company, Inc. 163

L

Leeds and Northrup Company 201
Lewis Foundry and Machine Division, Blaw-Knox Company 4
Lincoln Engineering Company 165
Linde Air Products Company 204
Link-Belt Company 206
Lintern Corporation 189
Loftus Engineering Corporation 222
Lovejoy Flexible Coupling Company 190
Lubriplate Division, Fiske Brothers Refining Company 184
Lumnite Division, Universal Atlas Cement Company 219

M

Mackintosh-Hemphill Company 187
McKay Machine Company, The 34
Medart Company, The 156
Mesta Machine Company 12, 13
Midvale Company 149
John Miles & Partner (London, Ltd.) 34
Morgan Construction Company 174
Morgan Engineering Company 152
Morganite, Inc. 7
Murray Manufacturing Company, D. J. 193

N

National Carbon Company, Inc. 180
National Erie Corporation 195
New York and New Jersey Lubricant Company 186
Norma-Hoffmann Bearings Corporation 230
North American Manufacturing Company 209

O

Ohio Electric Manufacturing Company 177
Ohio Steel Foundry Company 167
Okonite Company, The 32
O. Z. Electrical Manufacturing Company 218

P

Peerless Pump Division, Food Machinery Corporation 168
Pennsylvania Transformer Company 171
Pittsburgh Lectromelt Furnace Corporation 36
Pittsburgh Rolls Division, Blaw-Knox Company 16
Pollock Company, Wm. B. 208
Poole Foundry and Machine Company 20
Post-Glover Electric Company 212

R

Railway and Industrial Engineering Company 145
Railway Siding Construction Company 191
Ready-Power Company, The 176
Reliance Electric and Engineering Company 22, 23
Rockbestos Products Corporation 227
Roller-Smith Company 15
Rust Furnace Company 21

S

Salem Engineering Company 9
SKF Industries, Inc. 210
Smeeth-Harwood Company 192
Speer Carbon Company 141
Square D Company 211
Steel Processing Company 217
Swindell-Dressler Corporation 214

T

Taylor Chain Company, S. G. 179
Tide Water Associated Oil Company 33
Timken Roller Bearing Company ..... Cover 1
Treadwell Company, Inc., M. H. 213

U

Union Carbide & Carbon Corporation 180, 204
Union Steel Castings Division, Blaw-Knox Company 144
United Engineering and Foundry Company 19

V

Vaughn Machinery Company 215

W

Wagner Electric Corporation 216
Waldron Corporation, John 194
Wapakoneta Machine Company 162
Ware Fuse Corporation 183
Wean Engineering Company, Inc., The 34
Wean Engineering Company of Canada, Limited, The 34
Wean Equipment Corporation 34
Wellman Engineering Company, The 148
Williams Gauge Company, The 164
Wilputte Coke Oven Corporation 150, 151
Wing Manufacturing Company, L. J. 160

Y

Yoder Company, The 14
Youngstown Alloy Casting Corporation 207

Here's a Proved way to set High-Standards in Design

When you've been around for 30 years you're bound to earn some sort of reputation. That's happened to Norma-Hoffmann bearings, and, in thousands of blueprints it gets put down in "blue and white" like this: *Norma-Hoffmann or equal.*

Designers tell us there are extra values in these bearings. That they can specify Norma-Hoffmann and right there a worry is off their minds.

We have certainly set up high enough standards to assure delivering these extra qualities. There's no secret how. It's explained in one word: *precision.*

NORMA-HOFFMANN
Precision
BEARINGS
BALL · ROLLER · THRUST

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONNECTICUT · FIELD OFFICES: New York, Chicago, Cleveland, Detroit, Pittsburgh, Cincinnati, Los Angeles, San Francisco, Dallas, Seattle, Phoenix

FOR 18 YEARS
never a bearing failure with Farval

FARVAL—*Studies in Centralized Lubrication* No. 106

EIGHTEEN years ago, Farval Centralized Lubrication was installed on a 10-ton overhead traveling crane in one of the steel mills in the Chicago district. A recent report on this early job states that the Farval systems are still in service, as good as on the day they were installed, and that since 1930 the crane has never been down for a bearing repair or replacement. In short, there has never been a minute's trouble due to faulty lubrication.

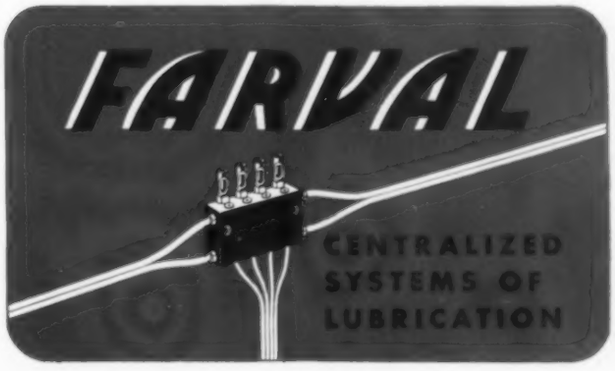
Two manually-operated Farval systems—one on the bridge and one on the trolley—serve 56 points of lubrication including the wheel bearings. In less than five minutes, every eight hours, the operator lubricates every bearing on the crane from two conveniently located hand pumps. No need to climb all over the crane and never a bearing is skipped. Grease consumption is greatly reduced because there is no waste, and drippage is practically eliminated.

More than 2000 Farval systems have been installed on cranes. Many of them are roller bearing cranes, where clean grease is essential and overlubrication should be avoided.

Farval delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, as often as desired. It does its work while the equipment is in operation. Farval—the Dualine System with the Positive Piston Displacement Valve —that has but 2 Moving Parts—is Fully Adjustable—and with a Tell-tale indicator at each bearing to show the job is done.

Write for Bulletin 25 for a full description of Farval. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



F-HP* MOTOR-STARTING SWITCH . . .

New Design for improved performance

Entire new line of CR1061 manually operated switches—general purpose, water-tight, explosion-proof types—now available. New from cover to heater. Check these features for:

EASIER INSTALLATION

- All wiring terminals easily accessible on top of switch unit
- Heaters have one mounting screw fastened in position to prevent incorrect mounting—stamped with current rating

POSITIVE OVERLOAD PROTECTION

- Employs sturdy bi-metallic protective device
- Positive indication power is off as switch handle moves to OFF position on overload

LONGER LIFE

- Self servicing—wheel-type movable contact cleans as it rolls against stationary contacts

**Fractional Horsepower*

- High interrupting capacity—arc snuffed qu as silver contact recedes into recess in ba

USE . . .

On a-c up to 1 hp at 110 to 220 volts
On d-c—¾ hp 115 volt, ⅓ hp, 230 volt
double-pole forms for 1 hp, 115 to 230 volt
Fill in the coupon and send it in for more info tion. *Control Division, Apparatus Dept., Ge Electric Company, Schenectady 5, N. Y.*

Apparatus Dept., Sec. 5676-276
General Electric Company
Schenectady 5, N. Y.

Gentlemen:

I want to know more about your new CR1061 switch
Please send me Bulletin GEA-2234E.

NAME .....

COMPANY .....

ADDRESS .....

.....

GENERAL ELECTRIC